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The Blast Furnace and Steel Plant

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The Blast Furnace and Steel Plant

VOL. VII. PITTSBURGH, PA., DECEMBER, 1919. No. 12.

Work of United States of Bureau of Mines

Industrial Co-operation With Government Agencies Encouraged. Blast Furnace Investigations—Establishment of Fellowships by Industries at Universities Suggested to Aid Research.

By VAN H. MANNING.
Director, United States Bureau of Mines.

It is unquestionably true that the most desirable end-point of progress can never be attained if development is allowed to be governed only by convenience and immediate results. The viewpoint of the Bureau of Mines is to look beyond the immediate necessities to the final goal to be attained, and it is my purpose that the bureau investigators shall keep this in mind in the progress of their work. It is true that in the first development of scientific control, that general conditions must first be established; when this has been accomplished the work must not be allowed to rest there, but must be carried on with a due appreciation of individual demands and the changing needs that progress in other lines brings about. Industrial coöperation with governmental agencies is highly desirable, and absolutism of control over the results of industrial research is to be deplored.

Iron ore and pig iron represent one-quarter of the value of the total yearly production of mineral wealth in the United States, but of the published researches of the bureau less than a tenth deal directly with problems in the iron and steel industry, and only about one-fifth with subjects that are at all closely related and would aid aid in the solution of those problems. Having already indicated that much of the bureau's best work has been done in coöperation with industry, I do not expect you to ask me why this is so, but leave the answer to this question to you. The work of the bureau on safety and health conditions around blast furnaces and steel plants is doubtless well known to you. Broadly speaking, the organic act establishing the bureau defines its work as (1) looking after the safety and health of the miner, and (2) the prevention of mineral waste. Inasmuch as its work is so defined, it can be readily understood that as the work expanded, the selection of a problem was practically altogether governed by whether or not it had to do with one or the other phases of the bureau's work. Thus, when the time came to consider the problems connected with the iron and steel industry, it was the safety side of the subject that first received attention. Consequently, the first bulletins issued by the bureau relating to the iron and steel industry had to do with safety in connection with blast furnace practice around steel plants, etc. In 1915 a bill passed by Congress authorized the establishment of 10 mining experiment stations of the bureau in addition to those which had already been established. The first three established in 1916, all of them in non-ferrous mining districts. Of the second three which were established, one was located in the Northwest, and to it was assigned the problem of the beneficiation of low-grade iron ores. As is well known to all of you here, it has been estimated that the iron ore reserves of the country will last about 30 years at the present rate of consumption. However, this estimate is based upon the utilization of those ores which at the present time can be treated profitably in blast furnaces. Likewise, as you also know, there is a tremendous tonnage of ores throughout the United States, and especially on the Nesabi range which are too low-grade to permit of their being treated in a blast furnace without having undergone some form of benefication.

A station was placed at Minneapolis because at this point is also the state university, in connection with which there is a state mining experiment station, and inasmuch as it is the policy of the bureau to attack, if possible, the problems of a state through or in coöperation with a state institution the station was built on the campus of the University of Minnesota. By the time the station had been started at Minneapolis, the participation of the United States in the world war had come about, and as the bureau was endeavoring to assist in the solution of problems connected with war work, the station at Minneapolis did not at once take up the work for which it was established, but turned its attention rather to the problem of the production of manganese alloys which might be used

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Paper read before fall meeting of the American Iron and Steel Institute.

in place of the high grade ferro-manganese formerly produced from imported ores. The station continued to give its entire attention to this work until the signing of the armistice.

In the meanwhile the state mining experiment station continued its work on the benefication of low grade iron ores and at the time of the signing of the armistice had made so much progress along this line, as had also private interests, that the bureau felt that instead of giving its attention to this subject it could better devote its energies to (1) a study of problems connected with the mining of iron ores, and (2) an investigation of the merits of those processes which have from time to time been suggested for the treatment of iron ores, other than in the blast furnace. It is perfectly well understood that the consideration of these processes is, so to speak, taking a long shot, and that iron and steel metallurgists as a rule do not believe that it will ever be possible to develop direct reduction processes. However, the bureau looks at the matter in this way. A pound of metal is a pound of metal, no matter whether it be iron, copper, lead, zinc or whatever else, and as such should not be wasted if it is possible to prevent. Inasmuch as one of the main functions of the bureau is to prevent waste, it should carefully inquire into the merits of every process whose originator claims for it the treatment of ores of lower grade than are being treated by present day metallurgical processes. Although processes may be devised for bringing up the iron content of an iron ore to a point where it can be successfully treated in a blast furnace, there will, nevertheless, still remain large quantities of ores which even after benefication will not be suitable for blast furnace treatment, and consequently, it would greatly add to the iron ore reserves of this country if some process other than the blast furnace process could be devised for the treatment of these ores locally for the recovery of their iron content. The bureau has only made a beginning along this line but trusts that the appropriations which are granted by Congress for its work will in the near future enable it to give this problem the attention it needs. In addition to the field of work I have just outlined, the bureau is, of course, also interested in all those problems which are confronting the iron and steel industry in connection with present day metallurgical practice. For example: As is well known, the socalled Bessemer ores have been largely depleted and the problem has arisen as to how it may be possible to convert non-Bessemer ores into Bessemer ores. Considerable progress has recently been made along this line by certain commercial concerns. However, the bureau is interested in this problem and is endeavoring to contribute its part to its solution.

Another problem is that of overcoming the ill effects of sulphur when high sulphur coals are used in steel making. The supply of low sulphur coals is running low and the steel industry at the present time finds it necessary to use high sulphur coals. Therefore, the problem presents itself of removing this sulphur from the coal or else adding to the steel after it is produced, some element which will neutralize the effects of the sulphur and at the same time in no way decrease the essential properties of the steel. The bureau is fully cognizant of the importance of both of these problems and will gladly take up more extensive work on them if its funds permit it to do so.

There is also the problem of the alloy steels; that is, of the production of steels, having peculiar properties by reason of the addition of rare elements. The bureau in connection with this work on rare metals has made an extensive study of the mining, treatment and utilization of these rare metals. This is a most promising field and it is to be hoped that in the near future it may be able to detail a sufficiently large number of investigators to this work to insure the securing of such additional data to that already possessed by the steel industry as should be available at the present time as to the influence of these rare elements on the properties of steel.

Because of the limited appropriations of the bureau, I realize that it can do no more than assist wherever possible on the problems now confronting the iron and steel industry. In other words, it can only hope to coöperate in the work which is being carried on by the industry itself and by the various technical societies. As you know, there was a time when each company or corporation endeavored to keep to itself all information gained in connection with the betterment of processes. Fortunately, it is becoming more and more recognized that this old idea is wrong and that the greatest progress can be made only by a free exchange of ideas and information. The technical societies have done much to do away with this old idea, until now, it is my impression, that a spirit of coöperation has sprung up in the industry which cannot help but be very beneficial in the solving of the problems confronting the industry. The bureau is coöperating, so far as its finances will permit, with the industry and in turn asks your coöperation in the solution of those problems which it may attack. Moreover, it will be only too glad to receive from the industry at any and all times suggestions as to the problems which should be taken up by it and which will benefit the industry as a whole. Referring to the Division of Research of the American Petroleum Institute, let me say that in response to my suggestion that the petroleum industry would find it well worth while to assess itself 1/25 of 1 per cent of the value of its output to be devoted to research, or approximately $1,000,000 a year, a reply was made that it would be better to provide three times that sum. If the steel industry were to provide 1/25 of 1 per cent of the value of its product for research for the benefit of the whole industry, work could be undertaken on a scale and with a degree of thoroughness that would be of incalculable benefit. I commend the plans of the American Petroleum Institute to your earnest consideration.

The industries should encourage technical and vocational training as well as research, because if this training precedes the trade training it makes for efficiency and economy. This education can be obtained, in one way through the establishment of a limited number of fellowships by the industries at your universities and colleges for the benefit of those who show

some ability to be educated as understudies in a particular line of work in which they could be employed. Unfortunately, many faithful employes are not financially able to give their children the particular education or the technical or trade experience which is desired in the business which their parents have given the best part of their lives to.

Another definite and concrete proposition has been submitted by Secretary Lane in his Americanization plan. In the mining and metallurgical plants there are many nationalities of foreign born or foreign speaking employes who are engaged in various lines of activities. They can neither read nor write the English language, and are, therefore, unable to understand the instructions or regulations which are prescribed by the employer, many of which are for the safeguarding of life and property.

I call your attention to and endorse as strongly as I can Senate bill 5464, by Mr. Smith of Georgia. "To promote the education of native illiterates, of persons unable to understand and use the English language, and of other resident persons of foreign birth; to provide for coöperation with the states in the education of such persons in the English language, the fundamental principles of government and citizenship, the elements of knowledge pertaining to self-support and home making, and in such other work as will assist in preparing such illiterates and foreign born persons for successful living and intelligent American citizenship."

The most recent statistics show 620,000 foreign born miners in this country, and about 75 per cent of these miners are non-English speaking foreigners. The best estimates from a number of the larger mining states are to the effect that the non-English speaking foreigners suffer twice the fatalities that the English speaking miners do. As the average state compensation is $3,000, which is a fair figure, the total economic loss each year to the country though the excess of deaths of non-English speaking miners alone amounts to $2,790,000. On the same basis it is estimated that the excess of non-English speaking miners injured each year amounts to 69,750 men. This is a loss in wages alone of $1,743,750, or a total for deaths and injuries of $4,533,750. This is entirely aside from the other costs of the industry in production lost.

There are certain radical elements whose gospel is violence, which have interfered with production when this country was in dire need of their services. The leaders, possessing an intelligence of cunning, have preyed upon the ignorance of other men. My plea, therefore, is that cooperative effort on the part of the government, states and industries will not only save human life and suffering in the allied industries, but will also be of great economic benefit, and will make loyal American citizens out of men who through their ignorance remain aliens.

Heating Furnaces and Annealing Furnaces

Continuation of Discussion on Fuels and Combustion Appliances. Pointers on the Most Economical Use of By-product Coke Oven Gas for Heating and Annealing Furnaces.

By **W. TRINKS.**

PART XII.

An increasing number of blast furnaces and steel works install by-product coke ovens, and use the surplus gas in open hearth furnaces, soaking pits, and heating furnaces.

The most economical all around use of this gas in a steel plant is a problem of great interest and somewhat exceeds the limits of this series. The following figures will, however, be found useful in connection with the problem. One pound of straight high volatile coal furnishes 3,300 Btu in the total volume of by-product gas. From 1,200 to 1,250 Btu are necessary to coke one pound of coal, while 200 Btu go into the benzol which is extracted from the gas. This leaves roughly 1,900 Btu in the surplus gas which is made from one pound of coal. With low volatile coals such as Pocahontas and Somerset coals, the calorific content of the total gas drops down to 2,500 Btu per pound of coal, while the heat demand for coking remains constant, namely 1,200 Btu per pound of coal; on the other hand, only 100 Btu go into the benzol, so that 1,200 Btu are available in the surplus gas from each pound of coal. From these figures, the amount of heat available from a pound of mixed coal can be computed for any mixture.

The information contained in these data is really more reliable than any figure giving the amount of surplus gas, because leaks into or out of the system will affect the quantity of surplus gas. However, some engineers prefer the information in that shape, and for them the following data will be of interest. One short ton of straight high volatile (Pittsburgh) coal produces from 6,300 to 6,400 cubic feet (62 degrees F. 30" barometer) of surplus gas (debenzolized) while a ton of mixed coal produces about 5,800 cubic feet of surplus gas.

The heat value of coke oven gas if made from Pittsburgh coal is 565 Btu cubic feet (high heat value, 62 degrees, 30" barometer). The corresponding value for mixed coal is 540 Btu. Both apply to debenzolized gas.

The specific gravity of coke oven gas is .39 referred to air; this low value is caused by the high hydrogen content, which equals 50 to 52 per cent. The gas also contains 30 to 32 per cent methane (C H). On account of this high percentage of hydrogen, the net or low heat value is comparatively low, namely 515 Btu. The gas contains from 2½ to 3½ per cent ethylene and other illuminants, which amount is sufficient to insure a luminous flame, unless the gas is thoroughly mixed with air before the combustion begins. For a complete statement of the properties of by-product coke oven gas, it is necessary to mention that each 100 cubic feet of gas contains 350 grains of hydrogen sulphide and 15 grains of carbon disulphide. The gas also contains slight amounts of CO, CO_2, O_2, and N_2.

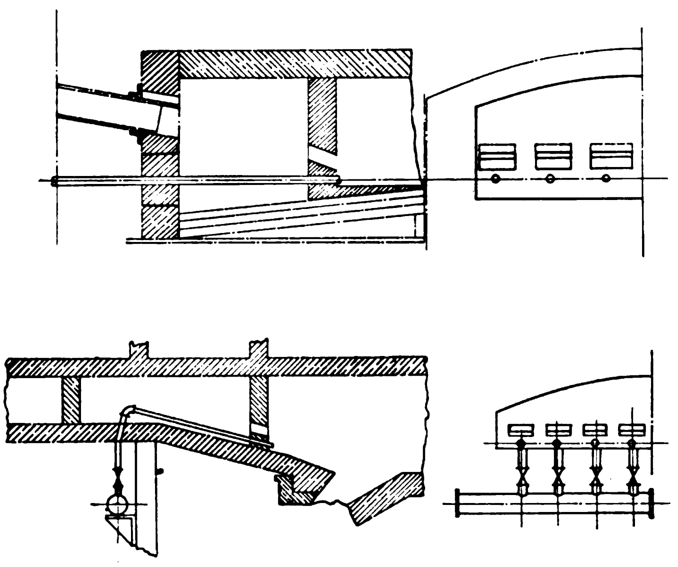

Fig. 81.

Just as with other fuels, the cost of 1,000,000 Btu is of importance with coke oven gas. But in arriving at the cost, a great difficulty arises because the gas is a by-product and, for that reason, "costs nothing." It has been said that the by-product coke plants can afford to give their gas away, and earn money from the sale of coke, benzol, tar, and ammonium sulphate. And yet, the gas has value, which, however, is more or less arbitrary, as long as the coke plant sells gas to the steel plant under the same management. At present (1919) prices of coal and labor, one steel plant values the gas at 5 cents per 1,000 cubic feet, while two other plants value it at 7 cents and 10 cents respectively. These low values are not maintained in coke plants which sell coke and gas for domestic use because domestic coke is worth less than metallurgical coke. In such plants the gas is valued at from 25 to 30 cents per 1,000 cubic feet.

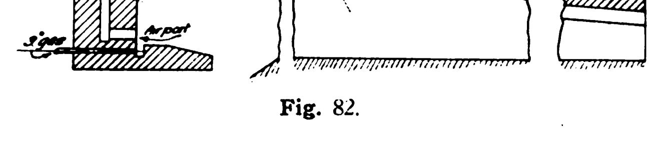

Fig. 82.

Turning now to the principal order of business, namely the use of coke oven gas in heating furnaces and in annealing, we find that it is indeed a very useful fuel. The principal difficulty in its use arises from its lightness. If the gas is used in appliances which were intended for a natural gas, or for producer gas, it will rise to the roof of the furnace allowing the air to drop down to the steel, scaling it a great deal. In consequence, correctly designed burners must admit the gas below the air. This statement holds even if the air is preheated to such an extent that it is lighter than the gas, because the gas itself will become heated by coming in contact with the air and will rise just the same.

Figs. 81 to 89 illustrate burner arrangements now in successful use with coke oven gas. The illustrations are sketchy, bringing out the burner features only, with intentional omission of detail design of other features. Figs. 81 and 82 show burners used on continuous slab furnaces with gravity discharge. In Fig. 81, gas and air are given a downward swoop to keep the air from rising, while in Fig. 82 gas and air impinge upon each other almost at right angles, producing an intimate mixture. For the purpose of increasing the luminosity of the flame, combustion was delayed in the furnace shown in Fig. 82, by making the preliminary air supply insufficient, and by introducing secondary air further on in the travel of the flame. It was found, however, that the furnace heated quite well if the supply of primary air was increased and the supply of secondary air was shut off. Both furnaces were equipped with brick recuperators, but the latter were abandoned. In practically all of the continuous slab and billet furnaces which I have inspected, the brick recuperators were abandoned or were about to be abandoned.

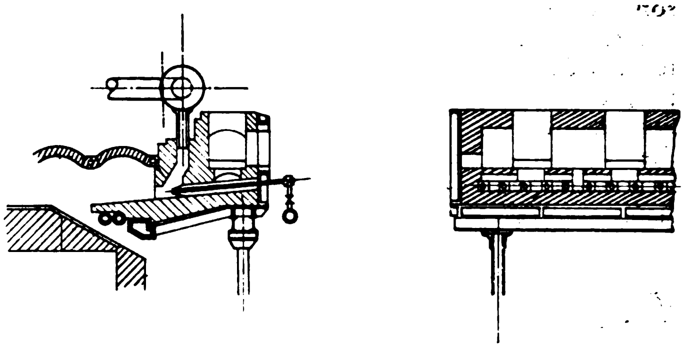

Fig. 83.

The discharge end of a continuous billet furnace is sketched in Fig. 83. Preheated air enters from above, while coke oven gas enters from the front, through small pipes.

Fig. 84 illustrates the introduction of coke oven gas into the head of a regenerative bridge furnace. It will be understood that this type of furnace is built on lines similar to those of an open hearth furnace. Many such furnaces have been changed over from producer gas to coke oven gas by working both checkers on air. In a Pittsburgh plant, furnaces of this type are operated sometimes on producer gas and sometimes on coke oven gas. The latter gas heats the steel more rapidly and the heaters like to enrich the producer gas, when they must use it, by admitting a little of the coke oven gas, thus working with a mixture. Of course, only one regenerator at each end is used for air whenever producer gas acts as fuel, while the other regenerator chamber preheats the gas. The height at which the coke oven gas is introduced must be carefully selected. If it is introduced too far down, the brickwork in the heads of the furnace suffers; and if it is introduced too far up, the gas will rise to the roof. The location indicated in Fig. 84 has produced good results, which however, does not mean that it is the best possible arrangement.

Fig. 85 shows how a coal fired continuous furnace was changed over for burning coke oven gas. Two layers of tile were placed over the combustion space, with the intention of getting whatever preheating effect that arrangement would allow. The gas is brought in through small pipes (2") and is allowed to mix with air in stages. Some air can enter directly from the outside through the 4-inch pipe which surrounds the gas pipe. Partly preheated air can mix with the gas as it leaves the 4-inch pipe which lies in an 8-inch pipe, and finally air swoops down through narrow slits over the gas and air mixture.

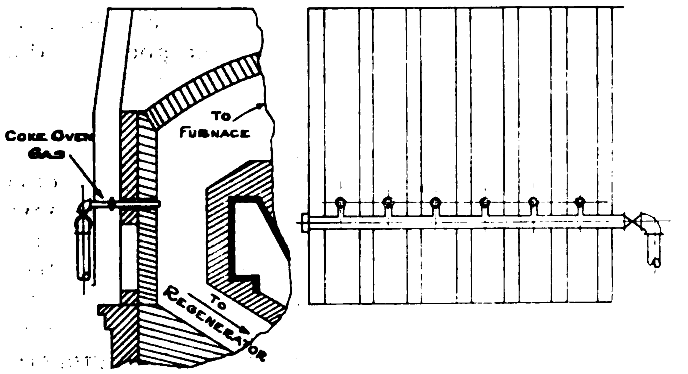

Fig. 84.

Coke oven gas may also be successfully burned after it has been premixed with air in ejectors or fans. The statements made for natural gas as a fuel apply just the same for coke oven gas, except that the gas pressure need not be so high, if air is induced by high pressure gas, because coke oven gas needs only 5½ volumes of air for one volume of gas.

Soaking pits form a type of heating furnace in which coke oven gas has been widely used. The gas has been introduced in various ways as shown in Figs. 86, 87, 88 and 89. It will be understood that all of these soaking pits were originally built for producer gas and that both the gas and the air checkers are used for preheating air, when oven gas is burned. In Figs. 86 and 87, the gas is brought in through pipes in the alleyway or slag pit between the checkers. The arrangement of Fig. 87 is somewhat better than that of Fig. 86 because it allows the gas to burn at the desired place, while in Fig. 86 the checkers will probably suffer. Both arrangements are open to the criticism that leaks in the pipes are almost certain to lead to fatal explosions. In Fig. 88, the pipe must be small so that the gas will enter with sufficient velocity to keep it down. It is claimed that this method gives a very uniform heating of the pits. In Fig. 89, the gas is introduced through a gas pipe which rests in a circular tile and is protected against burning off. In soaking pits using coke oven gas, the heat consumption is about 1,000,000 Btu per ton of steel.

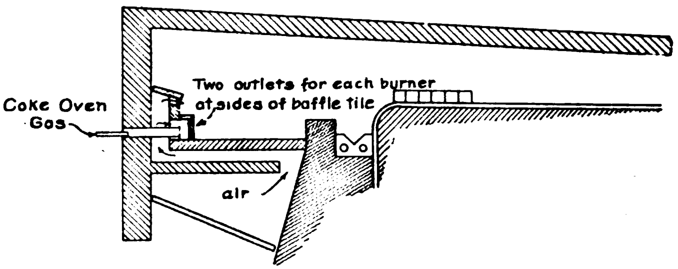

Fig. 85.

The supply of coke oven gas is fairly steady, while the demand varies. Whatever irregular excess is available, is burned under boilers, particularly on Sundays.

Heaters claim coke oven gas is very hard on brickwork.

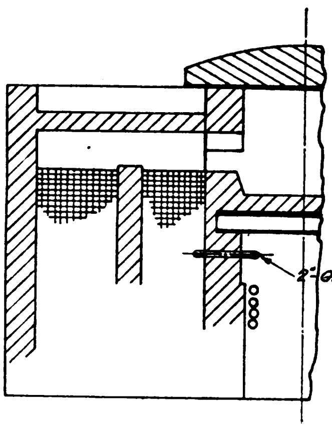

Fig. 86.

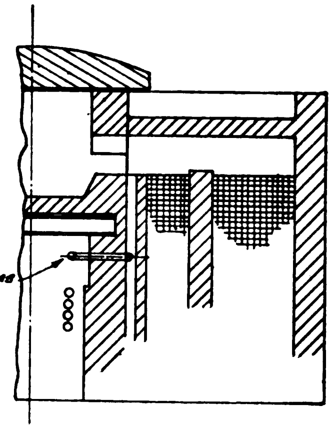

Fig. 87.

From the foregoing examples, it will be noted that coke oven gas does very well in heating furnaces without the admixture of tar. In this respect, heating furnaces differ from open hearth furnaces, in which the coke oven gas is usually "fortified with tar." The reasons for the use of tar in open hearth furnaces lie outside the range of this series of articles.

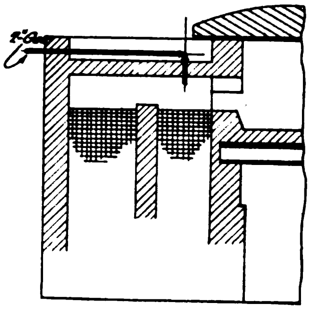

Fig. 88.

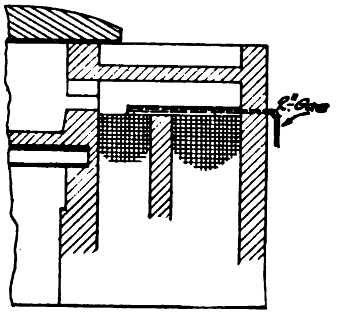

Fig. 89.

A large part of the information underlying the present installment was furnished by H. Koppers Company of Pittsburgh, Pa.

The Effect of Sulphur on Steel Castings

Minute Scrutiny of Sulphur Not as Essential in Making Steel Castings as Design, Composition, Molding, Steelmaking and Annealing Practice—Basis of Accepting Steel Castings Should Be Broader.

By A. E. WHITE.

It is not the object of this paper to add any new evidence to that which already has been presented. There has been no opportunity, since the writer was requested to prepare a paper on this subject, to make experiments and tests. It is the object of the paper to plead for a thorough survey of the items which affect the quality of steel castings and to judge of their acceptability on the basis of the properties they possess rather than to lay undue emphasis on one or more disputed points.

Considerable has been written concerning the effect of sulphur in steel. Numerous writers have pointed out that sulphur in percentages much above 0.04 or 0.05 gives material showing undesirable qualities. Now and then someone suggests that sulphur in percentages greater than 0.04 or 0.05, possibly as high as twice the values given, in no way affects the quality of the steel. Much that has been written is in the way of exposition and is not supported with evidence. Furthermore, a considerable amount of the evidence submitted is so beclouded by other factors that the data is valueless. Practically all of the literature discussing sulphur deals with its influence in rolled or forged steel and not in cast steel. Between cast steel on the one hand and rolled or forged steel on the other, there is, in the writer's opinion, a vast deal of difference. Therefore the observations on the influence of sulphur in rolled or forged steel, relatively speaking, may have little bearing if applied to cast steel. This, briefly stated, is the status of the question at the present time.

Factors Affecting Quality of Castings.

Broadly speaking, there are five main factors which affect the quality of steel castings. These are design of castings, composition, molding practice, steelmaking practice and annealing practice.

Included in the molding practice may be listed the kind of mold, whether of green or dry sand; method of venting; weight and location of riser; method of gating; character of cores; length of time mold is kept around metal after pouring, etc.

In the steelmaking practice may be included place of recarbonization, whether in furnace, converter or ladle; size of heat; number of castings to be poured from a given ladle; temperature of pouring, etc.

In the annealing practice may be included the evenness of furnace temperature; the temperature employed; the time consumed in bringing to heat; the time at heat; the time consumed in cooling; the type of castings placed in a given furnace, whether all light, all heavy, or mixed; the type of furnace used, whether a furnace designed for heavy castings employed on light ones or vice versa; character of flame, whether oxidizing, reducing or neutral; etc.

There are times when too little attention is given to the question of design of steel castings. Many designs are made by men who know too little about the characteristics of metal when it is changing from a liquid to a solid. Much improvement in the matter of quality of finished castings could be brought about by closer coöperation between the designer and foundryman, and it is trusted that as time goes on, this suggested closer coöperation will become more and more common.

Purchaser Depends Upon Foundryman.

In general, the steelmaking and molding practice is of an acceptable character. In large measure, however, the purchaser is in the hands of the founder since it is not feasible for him to employ as expert a steelmaker or steel founder as the steel-casting operator can afford to do, and only by the employment of an abler steelmaker or founder can he expect to properly pass upon these phases of the process. Even if he can get a man of suitable experience, it is questionable if he should employ him, for by so doing, a status of divided authority in the steel castings plant would develop, and such a condition would be most unsatisfactory and in fact, quite impossible. Also, by chemical, physical and visual tests the purchaser can gather sufficient information regarding the character of the castings to decide whether or not they are acceptable, so that he is not as much at the mercy of the founder as might appear to be the case at first glance.

The writer believes much greater attention should be given to the matter of annealing in the future than has been accorded it in the past. As a rule, steel founders have not awakened to the latent possibilities of scientifically controlled annealing. Many furnaces bear indications that the only things thought of in their design are walls, a floor, a roof, and some kind of ports for the admission of heat.

There seems to be an utter disregard of such questions as fuel efficiency, through proper combustion and control of heat losses by radiation and by the stack; character of the flame, whether oxidizing, reducing or neutral; scientific temperature control, for in most furnaces there is as much as 200 degrees F. difference in temperature in different portions of the same furnace; accurate temperature measurements, for such furnaces as have pyrometers usually have only one and it is neither frequently calibrated nor does it necessarily record the real conditions in the

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Paper read before American Foundrymen's Association.

furnace because of the varying temperature distribution in the same; and care in the selection of only pieces of approximately the same cross section for each furnace per anneal, for there exists a more or less haphazard method of placing castings with different cross sections in the same furnace with the resultant of either overheating the thin ones or failing to remove the dendritic structure in the thick ones.

It was the writer's privilege in the fall of 1916 and the winter of 1916-1917 to visit nearly all of the important steel casting plants in the eastern half of the United States. It was also his privilege to have under his supervision the inspection of all of the steel casting plants producing ordnance material for the United States army from January, 1918, until he left the service in March, 1919. As a result of this experience, he has come to feel to a greater and greater extent that the acceptance of steel castings should be placed on a broad basis and that the minute scrutiny of castings for a few hundredths of a per cent of sulphur is both irrational and unwise.

To talk about the effect of an increase of 0.01 or 0.02 per cent of sulphur when by improper annealing, improper steelmaking or by improper foundry practice, properties many times worse than those produced by sulphur are acquired by the steel, is, in the writer's judgment, placing undue emphasis on the wrong factor.

Sulphur in steel may increase blow holes—it is granted that this is a disputed point—but assuming that it does, it will not do so to nearly the same extent as an improper temper to the mold; improper venting of the mold or core, especially the core; or an improper pouring temperature. It may increase shrinkage, but it will not do it nearly as much as an improper casting design, an improper pouring temperature, or too rapid a heating or cooling during the annealing. It may decrease the metal's resistance to shock but not to the degree that a poorly designed casting will, or one in which the metal has been overheated, burned or under-annealed with the dendritic structure still in evidence.

It was because of the feelings expressed in the preceeding paragraph that the writer championed, while connected with the ordnance department, a more liberal specification as applied to sulphur, though accompanied at the same time with such a method of inspection at the casting plant consisting of an examination of test bars, annealing lugs, visual examination, etc., that the real quality of the castings, or as near real as could be obtained, might be ascertained.

Brittleness in Nickel-Chrome Steels

Investigation Into the Causes of Brittleness Acquired by Nickel-Chrome and Other Steels as the Result of Slowly Cooling From the Usual Tempering Temperature.

By F. RODGERS.

The object of the present note is to put on record some of the principal results of an investigation into the causes of the now fairly well known brittleness which is known to be acquired by nickel-chrome and other steels as the result of slowly cooling them from the usual tempering temperature. Another aim of the investigation was to discover if possible a means of discriminating as to toughness or brittleness so far as the said source is concerned, while avoiding destruction of the article.

Commencing at a time when there was little or no general knowledge of the subject, trials showed that the following classes of steel were all subject more or less to development of brittleness in a corresponding manner:

Nickel-chrome steels.
Carbon steels (carbon, 0.20 to 0.40 per cent.).
Nickel steels.
Chrome vanadium steel.

It was found that in hardened samples which were quenched from the usual tempering temperature, the Brinell hardness number was consistently higher (from 10 to 40 higher) than the fellow samples which were slowly cooled from the tempering temperature. Possibly this difference in hardness might be made use of for discrimination in cases where the class of steel is definitely known, but it would probably be found too slight for sole reliance.

A large amount of microscopic work only led to definite discrimination in one or two quite special cases. This work is being carried much further upon some novel lines, and therefore reference to it is for the present deferred.

Considerations which led to a research by critical point determinations were found to be well justified, and the results so attained probably throw more light on the origin of the brittleness and toughness under consideration than any of the other work so far carried out. Typical heating and cooling curves (shown at the meeting) illustrate the important observation that the absorption of heat upon heating commences at a temperature usually between 400 degrees and 500 degrees C., so that the usual tempering temperature, namely, between 600 degrees and 650 degrees C., lies in a zone where a very material absorption of heat and therefore re-solution of carbides has taken place. Steel quenched from 600 degrees to 650 degrees C. therefore has a different constitution from that which is slowly cooled, which undergoes a change by reason of the carbides falling out of solution in the

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Paper read before fall meeting of Iron and Steel Institute.

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range 650 degrees to 400 degrees C. It is a well-established fact, thanks to the researches of Brearley, that it is slow cooling in this particular range which results in brittleness.

This view is well supported by the difference in Brinell tests under the two treatments. It appeared reasonable to inquire whether a piece of steel might be put into the standard tough condition by a process of cooling at a suitable rate from the usual hardening temperature to the tempering zone, and then quenching. A few experiments made on these lines did not give promising results, but the field to be covered is a very wide one, and it is conceivable that much better results may yet be attained. In the meantime, the theory advanced cannot be said to be definitely supported by this experiment.

The difference in the behavior of a steel, according as it is quenched or slowly cooled from the tempering temperature, depends fundamentally on the condition previous to the tempering process. Experiments were made upon "as rolled" and also hammer cogged bars, in some instances the first quenching or hardening being entirely omitted. The results indicate in a general way that the more a steel is worked the greater is its susceptibility to "tempering brittleness." This conclusion may be regarded, however, in another way, namely this: The impact figure which can be obtained from the same steel is raised both by the work which has been put upon it, and by suitable hardening, provided the same be followed by suitable tempering conditions (that is, rapid cooling from the proper tempering temperature). Exceptions have, however, been found to this generalization.

The degree of aggregation of the constituents (carbides and solvent) is visibly controlled by the treatment above the critical temperature—initial temperature, rate of cooling, the nature of the working put upon the steel, and its finishing temperature. This is well seen in the microstructure of the steels in question. There is comparatively little time lag in the tempering operations concerned, in other words, an equilibrium condition is rapidly and consistently attained in tempering. So distinct is the relation in the tempering zone, that the author inclines to the view that there is a definite solubility of carbides in the solvent corresponding to the temperature, while at the same time the mobility of constituents once aggregated is relatively slight. Thus in cases where the constituents are fairly distinctly separated from one another, as for example in annealed material, heating in the usual tempering zone is insufficient to produce a homogeneous solution, but (at, for example, 620 degrees C. in a steel of the type 0.3 per cent carbon, 3 per cent nickel, 0.75 per cent chromium) a certain amount of the homogeneous solution, corresponding to the temperature, is formed where the constituents are contiguous, yet portions of each comparatively massive constituent remain unaffected, being unable to approach one another by migration or diffusion. When the constituents are, by virtue of suitable hardening, more homogeneously blended (usually so as to be indistinguishable by the microscope) the distribution of the low-concentration solution formed in the usual tempering zone is correspondingly more intimate. It is the retention, so far as is possible by quenching, of this low-concentration solution, which, despite admixture with free, though microscopically unresolvable, carbides and possibly solvent also, gives the maximum combination of the properties sought in these steels, namely, toughness with a certain hardness. It will be understood that the author does not entirely concur in the inference usually drawn from the occurrence of intergranular fractures* in nickel-chrome steel hardened from too high a temperature (e.g. 1,000 degrees C.) and then tempered, followed by slowly cooling; this inference appears to be that this is a magnified edition of what happens in steel properly hardened but similarly wrongly tempered. Crystal grain is often practically indefinable in cases where the hardening is correct, and it appears to him therefore that an explanation upon the above lines is complete without reference to crystal grain. Upon heating to the dangerous zone (e.g. 450 degrees C.) there is sufficient mobility for the carbides to fall out of solution, while the nature of the mixture still remains very intimate, i.e., there is no microscopically visible aggregation of the constituents; this statement does not differ materially from the ordinary conception of tempering. His view is further, however, that at this stage (with probably a minimum of true solid solution in existence) there is minimum toughness since the material is essentially but a mixture of carbides and solvent intimate enough to have mechanical properties appreciably different from those of the solvent, but lacking the toughness which it would have if infused throughout with the tough low-concentration solution. Cooled in any manner from this condition, toughness is not regained, for there is no solubility available to yield control below this temperature. Heated to the usual higher zone, in which there is a degree of solubility, toughness is produced, provided that the cooling through the danger zone be rapid enough to prevent dissociation of solution so formed.

It is conceivable that the aggregations of molecules of carbide and solvent, presumably produced upon heating, in tempering, are not completely redissolved, in the usual tempering zone. At least it ought to be remembered that, in a certain temperature zone, a combination of these two actions, aggregation and resolution, is probably taking place; in the lower part of the temperature range (say below 400 degrees C.) aggregation alone is possible; at temperatures from say 450 degrees C. upwards, re-solution proceeds to an extent increasing with the temperature, side by side, it may be, with further aggregation.

The author is indebted to a number of firms for kind coöperation, provision of samples, etc., and would especially thank Messrs. Taylor Bros. & Co., Ltd., Leeds, and J. L. Herbert, their works manager, without whose sustained collaboration the research could not have been carried to completion.

This paper was not ready in time for presentation in its complete form at the present meeting, but the author proposes to submit the full paper for the next meeting, in May next year.

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* Philpot, Institutions of Automobile Engineers, April, 1918.

X-Ray Applied to Examinaton of Metals

Technique, Possibilities and Limitations of the Examination of the Physical Condition of the Ordinarily Invisible Portion of Metallurgical Products.

By **W. E. RUDER.**

The remarkable property of X-rays, by means of which one is able to see through otherwise opaque objects, has, from the time of their discovery, made a strong appeal to the imagination. All sorts of remarkable powers have been attributed to these rays. The results actually achieved have been truly marvelous and yet much that we have been led to believe in the past is, even today, still in the realm of the "hoped for" to those whose lives have been devoted to the study of this subject.

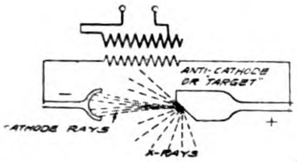

Fig. 1—Production of X-ray.

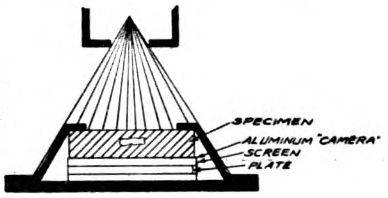

Fig. 2—Arrangement of protecting photographic plate.

In presenting this paper I do not pretend to be offering anything that is essentially new or orginal. My sole object is to give a brief outline of the principles underlying the application of X-rays to the examination of metals and to tell what can reasonably be expected from such application under present existing conditions. If the results given are in some cases apparently contradictory, it should be borne in mind that an exact technique has not yet been worked out.

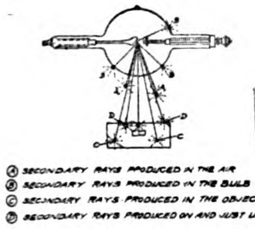
A
B
C
D
Ⓐ SECONDARY RAYS PRODUCED IN THE AIR
Ⓑ SECONDARY RAYS PRODUCED IN THE BULB
Ⓒ SECONDARY RAYS PRODUCED IN THE OBJECT
Ⓓ SECONDARY RAYS PRODUCED ON AND JUST UNDER SURFACE

Fig. 3—Rroduction of secondary radiation.

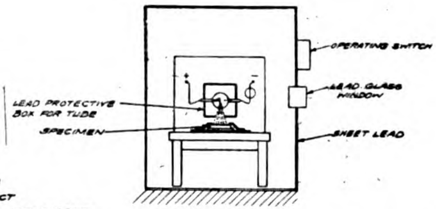

Fig. 4—Protection of operator.

During the last decade the metallurgist has found it increasingly necessary to keep in touch with the achievements of those working in the realm of so-called pure science. The constitutional diagram, the phase rule and the thermo-chemistry of furnace reactions quickly became the instruments by which the metallurgist gauged his advances.

Since the announcement of their discovery in 1895, the study of Röntgen or X-rays has opened up the entire field of atomic physics and discloses much of the part that electricity plays in the structure of matter.

At least two distinct phases of this study are of particular interest to the metallurgist, namely, the determination of the crystal structure, and the atomic arrangement in crystals of metals and alloys, and the examination of the physical condition of the ordinarily invisible portions of a metallurgical product. It is the purpose of the present paper to deal only with the second of these applications, outline its technique, possibilities and limitations.

In 1915 Dr. W. P. Davey* described his investigation of a steel casting by means of X-rays and showed that flaws of certain kinds, such as blowholes or fair sized slag inclusions, were readily discernible. Since that time much interest has been shown both in this country and abroad, in the practical application of this new tool.

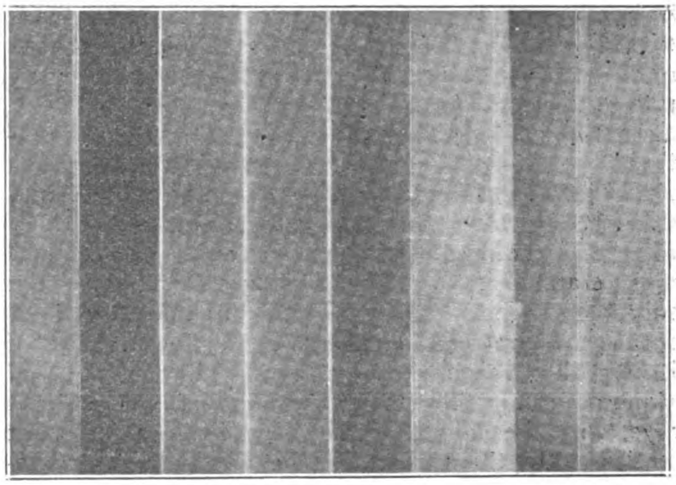

Fig. 5.

X-rays are ether waves or vibrations of very short length† (.000,000,048 — .000,000,036 mm.) produced by the impact of cathode rays upon any substance (Fig. 1). Cathode rays are streams of negatively charged electrons given off by the cathode under the action of high voltage and under conditions most favorable to ionization. These conditions may be that of a rarefied atmosphere (.006 — .001 m.m. Hg.) or of a heated cathode in a very highly evacuated tube. In either case the cathode discharge is electronic. The latter, however, represents the most advanced art in X-ray tube manufacture. Each electron in the cathode stream sets up a magnetic field perpendicular to its

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Paper read before New York meeting of the American Iron and Steel Institute, October 24.

*G. E. Rev. 18, 25-27, 134-6 (1915).

†Visible light rays range from .000813 to .000330 m.m. in wave length.

path, and the very rapid retardation of these electrons as they strike a substance (an X-ray target, for example) sets up electro-magnetic disturbances or ether waves of short length, and consequently great penetrating power. These are called X-rays. Rays produced in this manner have the power of producing fluorescence from certain salts of the alkali and alkali-earth metals, of ionizing gases, of affecting the electric resistance of a selenium cell, of producing physiological effects in living tissue, and of affecting the photographic plate in much the same manner as visible light.

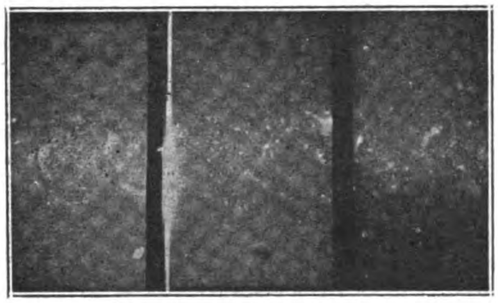

Fig. 6—Radiograph of electric weld.

Several factors govern the effectiveness of these X-rays. First, the velocity of the impinging cathode stream which is directly dependent upon the voltage applied; second, the intensity of this stream determined as current flowing through the tube; and third, the nature of the metal in which the X-rays are produced. Waves of very short length are usually spoken of as "hard" and the longer ones as "soft." Hard rays have the greater penetration and for this reason high voltage is required when penetration is the primary consideration. In making a radiograph, however, not only is the penetration important, but the time of exposure is directly dependent upon the amount of X-rays that reach the emulsion. The intensity of radiation diminishes as in the case of visible light rays, with the square of the distance from the point of source to the surface of the object to be radiographed.

When visible light rays fall upon a transparent body, only a certain percentage of the rays pass through. Some are absorbed and others are reflected. Just so in the case of X-rays. Part of the impinging rays are "reflected," that is, "characteristic" rays are produced, the incident rays setting up a secondary radiation characteristic of the substance upon which they fall. The second part is "absorbed" or "scattered" and so dissipated. Characteristic rays are produced only when the incident primary rays are more penetrating than the characteristic secondary radiation and their production is analygous to the production of fluorescent light.

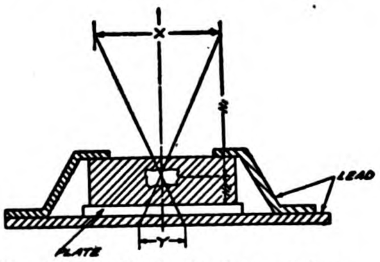

Fig. 7—Method of determining depth of flow.

Scattering is produced by deflection of the rays by internal structural surfaces in matter of any kind and increases with the thickness and atomic weight of the scattering medium. It corresponds to the scattering of visible light by fog. It is, then, this scattering and production of secondary radiation that puts such narrow limits upon the use of X-rays in examing substances, particularly those of high density, such as are encountered in radio-metallography (Fig. 3).

The absorption of homogeneous X-radiation may be expressed by the following equation:

$$I = I_o \epsilon^{\lambda x}$$

I_o = the intensity of the incident beam.
I = the intensity of the emergent beam.
ϵ = 2.7182.
λ = coefficient of absorption of the substance.
x = the thickness of the substance.

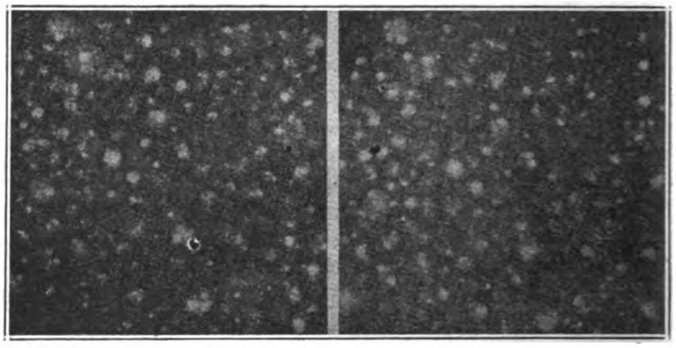

Fig. 8—Stereoscopic radiograph of a portion of the block of uncarboronized copper. When viewed through a hand stereoscope this shows the size and relative depths of the pores.

Except in a very general sense, this equation is of little value in practice, because we always have to deal with radiation that is far from homogeneous.

Bearing in mind the foregoing brief survey of the underlying principles governing the application of X-rays, let us now consider their application to the study of metals.

Unfortunately we are at present, limited in examining metals by means of a fluorescent screen such as is used by physicians, to about .01 to .02 inches thickness of metal, and obviously internal flaws in such thicknesses would be relatively unimportant. For the examination of a manufactured article, for the inspection of assembly, the screen has been successfully used. For most purposes, however, a photographic plate must be used so that the cumulative effect of time may be utilized.

Photographic plates do not have the same sensitiveness to all wave lengths of X-rays, so that when working with very short wave lengths in work requiring a high degree of penetration, a different plate will be needed than when working with soft rays of longer wave length. For this reason only plates made for the particular purpose should be used.

The time of exposure is appreciably shortened by the use of an intensifying screen, a fluorescent surface placed close to the plate and which under the influence of X-radiation, emits visible light rays of a color which readily affect a photographic plate. In metal radiography the use of such a screen is a necessity, owing to the thickness and high atomic weight of most metals. Calcium tungstate, which emits a blue light under these conditions, is particularly suitable for the purpose. It must, however, be of very fine grain because this grain shows up in the negative.

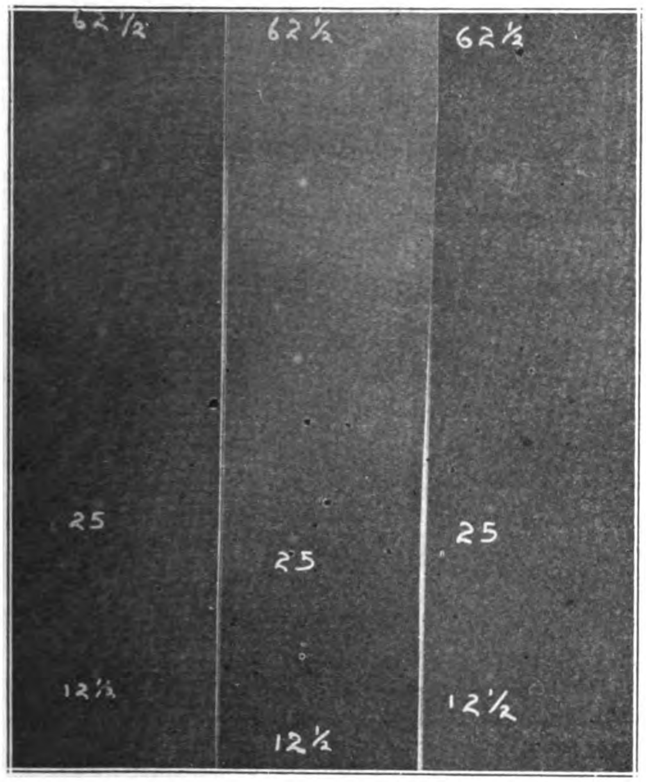

Fig. 9. Fig. 10. Fig. 11.

Fig. 9—¾" steel plate .0065" slit, ⅛" above photographic plate, positive. Fig. 10—¾" steel plate .0065" slit on side away from photographic plate, positive. Fig. 11—¾" steel plate slit next to photographic plate.

Radiographs are detail shadowgraphs and as the rays cannot be focused as in ordinary photography, the image will always be "life size" or larger. Moreover, the rays producing the shadows are not parallel but emanate from a point source. For this reason variations in intensity caused by differences in density in the object will be sharper when near the emergent side, and their sharpness will diminish and their size apparently increase as they are nearer to the incident side. This point source distortion is diminished by increasing the distance of the tube from the object, at the same time, however, decreasing the intensity of the rays.

As previously pointed out, X-rays impinging upon any substance, air, glass, wood, metal, etc., produce secondary rays which also have an effect upon the photographic plate. In metal radiography it becomes of primary importance to guard against this extraneous radiation by protecting the plate on all sides except in the direction in which it is desired to radiograph. This protective sheath is usually made of lead, and in examining thick sections should be at least ¼ inch thick. The aperture in the protective box surrounding the X-ray tube must be small enough to prevent the spread of the rays beyond this protective sheath.

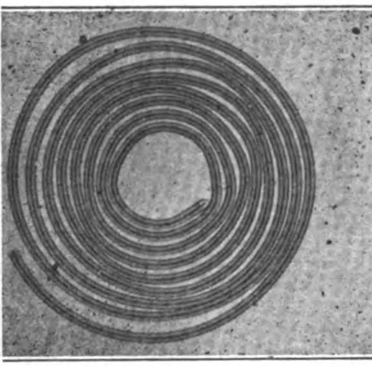

Fig. 12—Radiograph of sheath wire (positive).

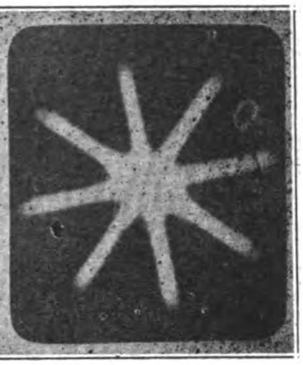

Fig. 13—Blow holes in iron casting

Most important, however, is the protection of the operator from the action of both the direct and secondary rays. Owing to the high penetrating power of the rays used, protection is even more important in metal radiography than in radio therapeutics. Too great care cannot be taken to guard against these rays. Complete protection should always be provided for. An arrangement providing such protection is shown in Fig. 4.

A suitable arrangement for the making of radiographs is shown in Fig. 2. The "camera" is merely a special plate holder, light tight, of course, and carrying an intensifying screen. The object is placed on this camera directly. If the sides are not parallel, unsatisfactory results, due to unequal penetration, will result. In the case of curved surfaces, a film and flexible screen must be used.

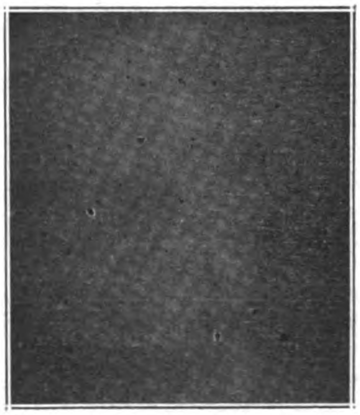

Fig. 14—Negative of electric weld.

The distance between the X-ray tube and the object is so regulated that a uniform effect may be obtained over the whole plate. For a 5x7 inch plate, this distance should be at least 15 inches.

The time of exposure is the most important consideration and has, unfortunately, been given little attention in previous publications. It is particularly desirable in investigating a new field that all data be given. In this case, voltage, current, distance from plate to tube, time of exposure and kind of plate should be recorded.

Now it is evident that, provided the voltage is high enough to cause even a small amount of radiation to pass through the metal, a radiograph can be obtained if sufficient time is allowed. The time required is also a direct function of the intensity of the rays; that is, of the current passing through the tube. The exposure may then be refered to in terms of milli-ampere-minutes (MA-Min.). at a certain spark-gap (voltage). The limit of Ma-min. a tube will stand is determined by the temperature of the target and the heating of the bulb. Most tubes, unless special arrangement for cooling is provided, will carry only 5-6 milli-amperes continuously, at the voltage required for this work.

M. H. Pilon describes an experiment in which he successfully radiographed 2.16 inches (55 mm.) of steel by an exposure of 2 hours and 48 minutes, using a Coolidge tube operating at 6 milli-amperes and 120,000 volts.

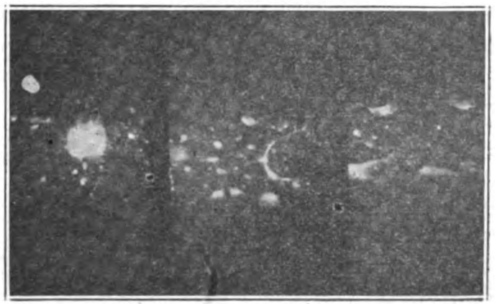

Fig. 15—Radiograph of electric weld.

Davey (Trans. Am. Electrochem. Sec. 28, 410), experimenting with a 15 inch spark gap (150,000 volts) was able to detect defects 1/64 inch thick in 1½ inches of steel with a 60 milli-ampere-minute exposure, while a 90 milli-ampere-minute with a 13 inch gap (130,000 volts) was sensitive to not less than 1/32 inch difference in the same total thickness.

With the best apparatus at present on the market, the metallurgist will be limited to the use of a 10 inch (100,000 volt) spark gap. This will require an exposure of about three hours at five milli-amperes to radiograph two inches of metal. This represents the present practical limits of the process. Of course, for purely research work, much higher voltages are available and have been used, making the practical radiography of greater thicknesses of steel a thing to be reasonably looked forward to, but for the present, this is still in the hands of the X-ray tube engineer.

There is another difficulty met with in radiographing greater thicknesses and that is that any flaws to be detected must be proportionately larger as the piece is thicker, particularly if located at any appreciable distance from the photographic plate. The scattering effect of the large mass between the flaw and the plate will, during the long exposure required, so fog the outlines of the image that it may not be visible, and even though a radiograph can be made, it will not with any degree of certainty show the presence of flaws really existing.

The table gives results of experiments showing the time of exposure under varying conditions which gave good radiographs, and may serve as a practical guide for the determination of the time necessary. Seed X-ray plates were used.

Thickness	Spark Gap	Expt. MA-Min.	M.A.	Distance Source to Plate	Remarks
.375"	10" (25.4 cm)	10	4.0	11"	No screen
.375"	10" (25.4 cm)	2^2	4.0	11"	With screen
.5 " (12.5 mm)	11" (28 cm)	7^3	..	20"	No screen
.55 " (14 mm)	10" (25.4 cm)	128	4.0	...	No screen
.55 " (14 mm)	10" (25.4 cm)	30	4.0	...	No screen
.5 " (12.5 mm)	13" (33 cm)	4	..	20"	No screen
.5 " (12.5 mm)	15" (38 cm)	1	..	20"	No screen
.56 " (14 mm)	15" (38 cm)	2.5	1.25	20"	With screen
.87 " (21.7 mm)	10" (25.4 cm)	160	4.0	15"	No screen
.87 " (21.7 mm)	10" (25.4 cm)	36	4.0	15"	With screen
.95 "	10" (25.4 cm)	60	4.0	15"	With screen
1.0 "	10" (25.4 cm)	112	4.0	12"	With screen
1.0 " (25.4 mm)	11" (28 cm)	45	4.0	20"	No screen
1.0 " (25.4 mm)	13" (33 cm)	19	..	20"	No screen
1.0 " (25.4 mm)	15" (38 cm)	10	..	20"	No screen
1.5 " (37.5 mm)	15" (38 cm)	90	..	20"	With screen
2.16 " (55 mm)	10" (25.4 cm)	650	6.0	?	
*.75 " (19 mm)	10" (25.4 cm)	5.6	2.8	22	

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*Copper.

A difference of 50-75 per cent in time of exposure may result from different density of the metal and from the character of the defects it is desired to show. This is well illustrated in Figs. 5 and 6, in which the composition of the various rods shown varied less than 1½ per cent.

In developing an X-ray plate, a slow developer must be used, due to the fact that the emulsion, usually thick and carrying a high silver content, is affected all the way through. Too rapid developments would fog the surface and the negative would lose sharpness.

Special X-ray plates, films and developers are now obtainable from reliable manufacturers. Radiographs are usually examined as negatives so that a greater density is required than when prints are to be made.

The relative depth of flaws may be determined either by radiography from two points and calculating the depth (Fig. 7) or by making a steroscopic radiograph as shown in Fig. 8.

Owing to the severe requirements in the matter of high voltage, currents, and long continued operation, the hot cathode or high vacuum tube gives the most satisfactory results, in metal radiography.

The examination of forgings for flaws presents greater difficulties than castings because such flaws usually occur as hair line cracks or lines which, unless they happen to run almost parallel to the path of the rays and in a straight line, would not be visible on the negative. Even under these favorable circumstances,

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differences in density due to these defects are difficult to detect, for the radiograph does not enlarge and shows only such defects as would be visible if exposed to the naked eye.

In order to determine the thickness of the smallest air inclusion which could be distinguished radiographically, two plates of steel were machined and ground to flat surfaces. In one of these a slot was cut to give a wedge of air of varying thickness. Each plate when finished was ⅝ inch (15.5 mm.) thick. The two steel plates were then bolted together and radiographed at 15 inches (38 cm.) gap. In this manner it was found that an air inclusion .021 inch (.5 mm.) could be detected in 1¼ inches (32 mm.) of steel and an air inclusion .007 inch (.2 mm.) could be detected in a total thickness of ⅝ inch (15.5 mm.) of steel. This is of course under the most favorable conditions, when it was known beforehand that the inclusion existed and just where it was.

A similar experiment made with a thinner wedge is illustrated in Figs. 9, 10 and 11. The thickness of the slot in mils. is indicated by the figures on the radiograph. In this case a total thickness of ¾ inch was used, and we find that when the inclusion is near the plate a thickness of .014 inch may be distinguished. When ⅛ inch from the plate a slightly greater thickness is necessary and when on the side away from the plate the air inclusion must be at least .030 inch thick and be detected under the most favorable conditions.

Figs. 5 and 6 show blow holes in steel castings .87 inch (21.7 mm.) thick. Fig. 2 is a radiograph of a sheath wire in which the core wire is of nichrome and the sheath of mild steel with Mgo insulation between them. Figs. 14 and 15 are radiographs of electric welds, showing the imperfections due to lack of joining and inclusions.

To summarize: From the point of view of those who are interested in the metallurgical application of X-rays, the following conclusions may be drawn:

1. The practical application of metal radiography in the workshop, bearing in mind time of exposure and available apparatus is at present limited to about 1½ inches of steel.
2. For purely research purposes and with special apparatus, somewhat greater thicknesses are possible of examination, but the results are increasingly harder to obtain and more difficult of interpretation as the thickness increases.
3. Only such inclusions as would, if exposed, be visible to the naked eye can be detected; hence the detection of hair line cracks or of very small sonims is very uncertain.

The author wishes to express his indebtedness to Dr. W. P. Davey, whose pioneer work in this line has been made liberal use of in this paper.

Main Hoists for Open Hearth Ladle Cranes

Series of Tests and Observations Made on the Main Hoists of Two Overhead Electric Traveling Open Hearth Ladle Cranes. Most Feasible Methods for Successful Information.

By W. W. GARRETT, JR.

The purpose of these remarks is to present a series of tests and observations made on the main hoists of two overhead electric traveling open hearth ladle cranes, and to suggest the most feasible method for their successful operation.

Tests were made on the main hoists of these two cranes, both of which were designed for 150 ton loads with a hoisting speed of 6 feet per minute. These cranes have a span of 65 feet and are built to handle their rated loads at the center of their girders with a factor of safety of five. Hoisting is accomplished by two 100 hp (crane rating) size G. W. 450 rpm 220 volt, Crocker Wheeler motors wired in series on a 240 volt circuit, and geared so that each motor can operate independently all of the four cable drums, thus giving to each motor one-half of the total hoisted load.

Braking is accomplished by the use of the standard Reliance friction brake, which will at all times permit the load to be raised, but set at the instant the motors are stopped and the hoist begins to lower. Any load regardless of its proportion will produce a friction sufficient to suspend itself in safety. The greater the load the greater the friction. At 150 tons or the normal full load of these cranes it requires approximately 50 per cent of the rated capacity of the hoisting motors to overcome the brake friction and start the load down. Should the crane be overloaded the starting power for the motors would obviously exceed this amount in proportion to the per cent of overload.

The first lift made with one of these cranes after it had been assembled, was an initial test load of 225 tons of steel rails, or an overload of 50 per cent. The crane being new, naturally the bearings were tight and the alignment of shafting not yet permanent; in other words, the crane had not been broken for regular service. Under these conditions, and with the two 100 hp motors operating in series, it required 53 ehp to start the main hoist up at no load, and 30 ehp to run up with no load. To start the hoist with the 225 ton test load it required 205 ehp. To run this load up it took 221 ehp. The motors driving this hoist are automatically operated by Cutler-Hammer magnetic control boards and master drums. This initial test load was started, hoisted and stopped several times, and in each instance the test meter read-

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ings were identically the same, thus indicating the exact uniformity of magnetic control. At the instant of hoisting this test load, observations as to the deflection of the crane girders were made. It was noted that one girder sagged 7/16 of an inch and the other 3/8 of an inch.

On lowering this same load, 128 ehp was required to start the motors and 157 ehp was necessary to drive the load down. It is especially interesting to note in this connection that practically 75 per cent of the normal rated capacity of the hoisting motors was taken to drive this 50 per cent overload down; thus giving ample assurance that the mechanical braking is safe and will handle any load that the crane may be called upon to serve.

To raise a ladle of molten steel, which is a load about equivalent to the rated capacity of this crane and the principal purpose it serves, it requires 136 ehp to start the load up, and 147 ehp to hoist this load at a hook speed of six feet per minute, when the crane was new.

After one of these cranes had been in service for several weeks, bearing and shafting troubles eliminated, and the crane put in the best of condition and broken in for steady and efficient service, another full load test was made. As in the former case a ladle of molten steel was handled. To start the hoist up this time required 105 ehp as against 136 ehp in the test when the crane was new. To raise this load at normal hook speed now required 99 ehp; as against 147 ehp in the earlier test.

Now the question arises, why not handle this hoisting with one motor? After the crane has been broken in and as the most severe service will necessitate the rated capacity of only one motor, would it not be better to use one of these motors as a spare only? This idea was advanced by some of our operating men. In trying out this plan the pinion has been removed from the shaft of one of the series hoisting motors. The wiring has been so rearranged as to make it possible by changing switches to transfer the hoisted load to either motor, reserving the idle unit as a spare. In case the motor in service should fail it will be an easy matter, they claim to throw the switches, replace the pinion on the spare and thus transfer the hoisting to the good unit. These changes they think, can be made in a sufficiently short time to prevent any danger of losing a heat of steel. It is claimed that less power will be required in operating one motor, and since it will be running at its normal rated load better efficiency will be obtained. In spite of the fact that this motor must operate at her full rating at all times they believe it will stand up under the strain.

In answering these points I shall first grant that one motor has sufficient power to operate the hoist; but it must be remembered that this motor must run at its full load capacity at all times, consequently the chances for failure are increased. If one motor is used the hoisting speed will be increased about 18 per cent; while the no load hook speed will be approximately doubled. This means higher operating speeds under full load conditions and much higher speeds under light load service; hence a marked increase in the general wear and tear of the cranes, and a shorter life for the motors. By increasing the hook speed we will save time in handling the steel, but our possibility for delays and accidents will be greatly increased. Since we must have a duplicate motor as a spare to insure positive handling of the steel the initial outlay in dollars will be the same, so we have saved nothing on the investment by the use of one motor. In the scheme of two motors in series, each unit will at all times operate below its rated capacity and at slower speeds, regardless of the nature of the service. Under these conditions we can assume that we have at least doubled the life of the motors, and I do not hesitate in saying that we have far more than doubled it. To substantiate this statement I shall cite the fact that in our five years of operation, under the series plan, we have never lost a heat of steel due to the failure of the hoisting motors.

It might be suggested that we use one larger unit and in this manner operate the motor below its rating. But our experience in steel production has taught us that by preventing a short delay in which the loss might be only one ladle of steel, we have saved in dollars the price of a spare, hence two motors are carried regardless of the wiring plan.

In regard to the point that the change to the spare unit can be made in a few minutes' time, I am in doubt as to whether this can be done in all cases. How shall the motor inspector in charge of repairs for these cranes, be absolutely sure that he can replace a pinion on the spare motor at the vital moment when it will be imperative for him to do so? It will ordinarily require the best effort of two men, under personal supervision of the inspector to do this job. These men must be signalled from various parts of the mill after the accident has happened, and it will take time to get ready to make such a change. When they are ready they must of a necessity work over a ladle of molten steel and in the midst of gasses and heat from the furnace and slag cars. From my own experience I can assure you this is a piece of work that demands caution as well as quick work. Furthermore what guarantee is there that the motor is in operating condition? It may have been sitting idle for months and then at the vital moment fail to run. If instead it had been running in series with the other unit, both under constant supervision, and receiving daily inspection under operating conditions, the chances for such a failure would be reduced to a minimum.

Other accepted advantages by the use of the two motors in series are: that it will be easier to reverse the motors, they will have less tendency to race; breaking from two separate units will be more positive; commutation of current peaks will be more easily accomplished; and the motors in series will act as a double booster to the line when the hoist is running down.

It is my opinion, and I believe most engineers will agree with me, that the two-motor series scheme is by far the safest, cheapest and most dependable plan. It may not appear to be the most efficient at first glance, but after taking both sides of the question into consideration, I am convinced that it is just as efficient as the less safe plan might be.

Notes on the Acid Electric Furnace Process

From the Point of View of Inclusions Resulting from a Process the Basic Electric Process Gives Conditions More Favorable for Their Minimum Than the Acid Process.

By L. B. LINDEMUTH.

In considering the electric furnace as a steelmaking instrument, whether acid or basic, we must always bear in mind that it offers the one method of manufacture by which we can obtain commercially either oxidizing or reducing conditions, and are therefore able to produce high quality steels at prices which are not prohibitive.

It will be necessary in this paper to assume that everyone is familiar with the metallurgy of the basic process, and it will, therefore, be mentioned only to point out differences or similarities between it and the acid process.

The electric furnace lined with sand, with the steel covered with silicious slag, varies from the basic-lined furnace with a basic slag, in that all of the constituents of the steel, except silicon, being in themselves basic, hold a different relation to the slag and lining, which are acid, than they do in a furnace where the bases are always in a very material majority. This difference in relationship affects not only the constituents of the steel but also influences the effect of the reducing conditions which make the electric furnace a superior steel making container.

How Phosphorus Is Removed.

In the basic furnace, phosphorus is removed from the steel by producing an oxidized condition. Slag containing the phosphorus is then scraped out of the furnace and a second slag of a definite composition is made up and introduced in any desired volume. In the acid process, however, the removal of phosphorus which is itself an acid, is not possible in the presence of an excess of silica, which is the stronger acid.

It is, therefore, unnecessary in the acid process to remove the slag provided it is possible to produce the necessary reducing conditions with the slag resulting from the melting-down operation. The acid process is, therefore, a one-slag process, but it is necessary to purchase scrap with the phosphorus and sulphur content below the maximum allowed in the finished steel, and in most cases the economy effected by a one-slag operation, compared with the basic process, would be offset by the premium paid for low-phosphorus scrap. To produce steel of a uniformly high quality by the electric process we have only to consider the production of a uniformly deoxidized silicious slag.

Unlike the basic process from which we can produce slag of a definite composition and a definite volume, the acid slag varies considerably, both in analysis and quantity. The controlling feature in the operation of the acid process seems to be the quantity of iron-oxide present at the time the heat is melted, irrespective of whether this oxide is introduced with the steel scrap as rust, or whether it results from oxidation due to air leaks in the furnace, or from the addition of iron ore. The slag volume in the acid process is controlled directly by the action of this iron oxide and silica.

Unfortunately, scrap in any scrap yard is variable with regard to rust. A small coating of rust on light scrap such as turnings, which is, in certain proportions a desirable scrap for an electric furnace, represents a much greater percentage of the scrap than the same coating of rust on heavier scrap.

Oxidation Due to Leaks.

The amount of oxidation due to furnace leaks is a variable with every heat, so that oxidation from this source is not necessarily at all consistent. Scrap charged in the evening and allowed to stand in the furnace until morning, or charged Saturday night and allowed to stand until Sunday or Monday will become oxidized, the amount of oxidation depending upon the weight of the individual pieces of scrap and the care which was used in sealing the furnace after it was charged. It, therefore, follows that the amount of iron oxide in a furnace during melting is a variable which it is impossible to estimate. With the iron oxide varying between heats, the slag volume will be similarly affected and there is no means of determining, before the heat is tapped, what percentage of slag volume there is.

The reducing conditions necessary for the production of the highest grade steel and for making heats within the specifications desired require a slag with a definite composition. To secure the proper slag without delaying operations, its composition must be judged solely by its appearance, and the fact that this slag is not obtained through reducing conditions alone makes the acid electric process one which requires more skill and judgment on the part of the furnace man than the basic process.

The acid slag after melting and before any additions are made is principally a complex silicate of iron and manganese, containing usually about 50 to 60 per cent silica, the remainder being principally oxides of iron and manganese. Practically all the manganese of the charge with the exception of about 10 per cent passes into the slag as oxide. The percentage in the slag, of course, will depend upon the slag volume.

The oxidation of the bath, and of the subsequent additions of manganese, appears to be controlled by the percentage of FeO in the slag. Whether the excess FeO is combined in some form of silicate, or whether there is free iron oxide I do not know, but

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whatever form the iron oxide is in, it acts as an oxidizing agent on carbon, silicon and manganese.

Further, this iron oxide cannot be appreciably or satisfactorily reduced from the slag by adding coal or coke dust as in the basic process for two reasons. First, a silicate in which the acid constituent is in excess is more difficult to dissociate than a silicate in which the bases are in excess, as in the basic process, and further the iron is more stable in a silicate in which the iron base is the predominating base, as in the acid process. In the basic process, with CaO and MgO the controlling bases in a basic silicate, iron oxide, whether free or combined with the other bases as a complex silicate, is easily reduced by coal or coke.

The second reason why it is impractical, and perhaps impossible to reduce FeO from the acid slag by coal or coke is that at the high temperatures in the vicinity of the arcs, SiO_2 is reduced by carbon. This phenomenon is familiar in the Bessemer process, where, when a certain high temperature has been reached, silicon in the bath increases during the blow.

In the acid process, therefore, if the slag is subjected to reducing conditions before it is of the proper composition, silicon will be reduced and the bath will contain a percentage of silicon varying with the intensity of these conditions and their duration.

As the iron oxide is reduced with difficulty, it must therefore be replaced by a stronger base. This is partially accomplished by the addition of lime. Manganese ore, if free from iron, should also be used for the same purpose. It is by replacing iron in the slag with calcium and manganese that it is possible to produce the necessary reducing conditions and secure uniform retention in the bath of subsequent manganese and silicon additions. Fortunately a slag with the proper percentage of lime and manganese can be determined by its appearance.

Similar to an Open-Hearth Slag.

An oxidizing acid slag such as obtained after melting down is black and opaque or slightly glassy similar in all respects to a common acid open hearth slag which it really is, chemically and physically. As soon as a heat is melted and the carbon is observed to be sufficiently low, lime should be added immediately up to 20 or 30 per cent of the slag volume, also it is preferable to add manganese ore sufficient to give 10 to 15 per cent MnO in the slag. When the slag contains sufficient lime for practical purposes it will no longer be black but will turn to a green or robin's egg blue and when cooled in the air, the surface will turn black or brown depending upon the proportions of iron and manganese oxide, black if it contains too much iron oxide, and brown if the iron oxide is sufficiently removed. Coke dust or coal should be used during the interval of adding lime and manganese ore, and until the heat is taped to prevent any further oxidation of iron. If all the constituents of the slag are actually combined with nothing in suspension, and the furnace is free from air leaks and working under a normal reducing atmosphere, a translucent, almost transparent, glassy slag of yellowish green or greenish blue is obtained. With this transparent slag and the greenish blue slag coated with a chocolate brown, reducing conditions are the best that can be obtained by the acid process. Subsequent additions of manganese and silicon will result in uniform losses and therefore give uniform results in the finished steel with respect to these elements.

A typical analysis of a proper finishing slag is as follows: SiO_2, 58.70 per cent; CaO, 21.25 per cent; MnO, 12.01 per cent; FeO, 3.10 per cent; MgO, 1.15 per cent; Al_2O_3, 3.35 per cent; P, 0.003 per cent; and S, 0.005 per cent.

If the slag during these operations shows a tendency to be porous or spongy it is still in an oxidizing condition. A proper acid slag should be free from sponginess or indications of gas pockets.

Three Alternatives.

Three alternatives to the ordinary scrap melting, one-slag, process can be used to overcome the variables introduced by rust or other oxidation, namely:

1. Duplexing from a converter, or open hearth furnace.
2. Slagging-off immediately after the charge is wetted.
3. Tumbling the scrap before charging to remove rust.

The first of these is possibly only in few plants. The second, to my mind represents the only satisfactory method of operating the acid process under the conditions found in the majority of electric furnace plants. The third is expensive, impractical, and does not prevent the variations due to oxidation in melting, but would produce more uniform results than the melting of scrap with variable degrees of rust.

It is important that the carbon content of the bath be as low as, or lower than that desired for tapping, before an effort is made to reduce the iron oxide percentage of the slag. Iron ore added after the lime and manganese addition, delays the operations and produces a slag which is thin and scorifying.

The yield of steel from charge to ladle is higher in the one-slag acid process, than in the two-slag basic process on account of the losses in the latter due to "slagging off." However, if the acid process were carried out with two slags the losses would be about equal.

Open Questions.

Statements that the acid process produces steel with fewer slag inclusions, and of great fluidity for castings, than the basic, are open questions. My observations of inclusions have led me firmly to believe that foreign inclusions are of far more frequent occurrence than any possible inclusions resulting from reactions within the steel made by any modern process. If inclusions are found where large masses of steel are not involved, such elements as ladle linings, nozzles, washes, pouring, and molding should be thoroughly investigated before any connection can be laid upon whether a process is acid or basic. From the point of view of inclusions resulting from a process, the basic electric process gives conditions more favorable for their minimum than the acid process.

Measuring Temperature of Molten Steel

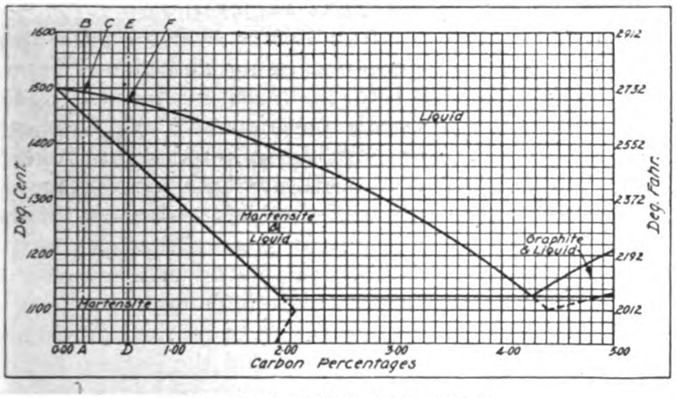
Use of Thermocouples, Radiation and Optical Pyrometers in Measuring Molten Steel Temperature—Explanation of Film, Rod and Pouring Tests—Temperature at Which Steel Leaves Furnace.

By F. W. BROOKE.

A large number of trials and experiments have been carried out by steelmakers along with the very commendable support of the makers of pyrometers to try and put the measurement of molten steel upon a scientific and fairly reliable basis. Most of the practical investigators have known all along that the measurement of actual temperatures to any degree of accuracy is at present too much to aim for, and have contented themselves with the effort of finding some indication such as a reading on an instrument which tells them when the steel is at the best temperature to produce either a certain type of casting or a first class ingot with the particular composition of steel they are handling, and that each time this reading is obtained the steel is at its best pouring temperature. In other words comparative tests have been their chief aim.

Use of Pyrometers.

Of the scientific instrument methods, we may consider thermocouples, radiation pyrometers and optical pyrometers. The thermocouple for temperatures of heat treatment has proved valuable. In the measurement of molten steel, however, only the rare metal couples can be considered, and even these do not withstand the very severe conditions of a bath of molten steel. Protective tubes, such as quartz tubes, have been tried, but have certain disadvantages. The mechanical strength of a long tube at the high temperature is inadequate; the chemical reaction of the slag in the case of basic operation is undesirable; and the varying thickness of the coating of slag to the tube as it is pushed through the slag causes a varying lag of temperature from the steel to the couple.



Standard carbon-iron curve.

The radiation pyrometers, of which the Thwing or the Foster type of fixed focus pyrometer appear to be most satisfactory, require no focusing and the method of handling them is simple. Both of these instruments also have an attachment for taking care of the change in black body conditions from true black body conditions when steel is poured from a furnace or from a ladle. The accuracies of these attachments are not so important, as they are the same for each heat as long as the steel is in a completely molten state. The first obvious objection is that owing to the slag covering in the furnace, and the difficulty and objection of maintaining an uncovered patch, the temperature cannot be read until the steel is being poured into the ladle. While this only allows for correction of temperature in one direction, it still has several valuable advantages. If the temperature of the steel is too low, preference can be given to the heavy castings of large section and the pouring operation carried out as rapidly as possible. If the temperature is on the high side, the steel can be left in the ladle or preference given to all the small castings requiring a relatively higher temperature, but perhaps the greatest value is a check and guidance for the melter and the foundry superintendent on the now existing more or less crude practical methods to be explained later. In the open-hearth furnace, when consecutive heats are being run to the same analysis and same conditions, a certain difference of temperature between the steel and the slag may be assumed, but this is not very reliable.

The principal objection, however, in the use of radiation pyrometers is the difficulty of not always being able to focus through a clear atmosphere and onto a clean stream of steel. In actual practice, it is found that smoky atmospheres and incandescent gases are constantly interfering, while in many furnaces the slag comes out of the teeming spout along with the steel and it is very difficult to known which of the readings recorded represent true conditions, or the same conditions as on the previous heat. There is also a tendency on the part of the observer to record the highest reading on the instrument and interference of a small amount of incandescent gas can escape notice. The following readings are typical of many tests made of a stream of steel leaving the nozzle of a ladle when pouring castings of easy section of about 30 to 100 pounds in weight and 0.25 to 0.35 per cent carbon, by the same instrument and the same observer, the resulting castings being of first class quality.

	Heat No. 7			Heat No. 23	
Mold	Degrees Cent.	Degrees Fahr.	Mold	Degrees Cent.	Degrees Fahr.
1	1510	2750	1	1530	2790
2	1560	2840	2	1540	2800
3	1515	2760	3	1210	2210
4	1740	3170	4	1560	2840
5	1530	2790	5	1490	2710
6	1580	2870			

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It is obvious that the readings on the fourth mold of heat No. 7 and the third of heat No. 23 were decidedly off, although every care was taken on both these heats to get uniform conditions and the error is undoubtedly due to incandescent gases and smoky atmosphere. Results both better and worse were obtained, and these are given as typical when every care was taken.

Practically the same limitations are noticed with optical pyrometers as with the fixed focus radiation type, the added disadvantage being that with every type of optical instrument there is more of the personal element brought in by the matching of intensities or the matching of colors. On the other hand, they are not so liable to damage by the too close proximity to the molten metal, as an observer has less fear of sticking a long tube up to the stream than of bringing his face too near.

Of the practical methods known, the film, rod and pouring tests are in constant use at various electric furnace plants, and they are all depending upon uniform conditions existing when each test is made. The use of the film test originated from the crucible steel practice, it being the best practice in making tool steels to first close all the melting shop doors; then to pull the pots after the required stewing and remove the lid and slag; make any additions and then carefully watch the bright surface of the steel for the first sign of an oxide film forming, this being the sign to commence pouring operations. In the absence of drafts, this served as a fairly reliable temperature indicator, as the crucibles and the mass of steel were usually the same, while the varying composition of the steel could be allowed for by pouring as soon as the first speck appeared, or so many seconds later. In electric furnace practice, this consists of using a steel spoon of uniform capacity, dried out thoroughly over the bath, and giving this a total covering of slag in the furnace. A sample of steel should then be taken, which fairly represents the whole bath, remembering that when a door has been left open for some time the steel near the door has become chilled, and with steel made in an electric furnace where all the heat is applied at the top only, the temperature of the steel directly under the slag is higher than the temperature of the steel near the bottom. Where this is the case, the bath must be thoroughly rabbled before any sample is withdrawn, and even then the sample should be taken at a place equidistant between the electrodes and half way down the bath, so as to arrive at an average temperature. The measurement of the temperature is then indicated by the length of time it takes for an oxide film to completely cover the sample after the sample is taken from the bath. This method is also influenced by the composition and physical condition of the bath, as for molten steels of the same temperature this time varies, principally with the carbon contents, the silicon contents, other alloy contents and the state of deoxidization. Therefore, final comparisons must only be made between steels of approximately the same composition and when the furnace is ready to pour. Care must be taken to keep the sample away from drafts and to have about the same amount of steel in the spoon each time. To show the range of this test it has been noted that first class high-speed steel ingots of a composition approximating carbon, 0.65; tungsten, 17.5; chromium, 3.75, and vanadium, 1 per cent, were produced when the film (with a later characteristic wrinkling of the surface) was formed directly the sample spoon came through the door, while good castings of about 0.25 carbon and weighing from 30 to 200 pounds were produced when the film took 60 seconds to form after passing the furnace door.

Factors Affecting Use of Rod Test.

The rod test has been used for many years as a rough indication of the temperature of many molten metals. The first publication noted by the author of this test being made a standard practice under uniform conditions was from a large Italian steel works. This test requires the use of rods of steel of both uniform diameter and fairly uniform composition, and consist of plunging the rod into the bath of steel and gently moving it through the bath for a uniform length of time. If the steel is cold there is a deposit of the bath on the rod, if the steel is hot the bath melts away or bites into some of the rod, with all intermediate conditions indicating varying temperatures. The skin of the bar, it will be noted, has an effect on this test; a newly rolled bar with a bright scaly surface tends to show a colder bath than is actually the case. The bar before being plunged into the bath should be of uniform temperature and in some steel works this is taken care of by bending about 12 inches or more of the end of the bar at right angles; holding the bar with the bend in a horizontal plane over the bath until it shows the first sign of sagging and then turning the end of the bar into the bath. This test again depends on the physical condition and the composition of the bath. This test is also very useful for testing the difference in temperature between the top of the bath and the bottom of the bath and is one of the best indications of the value in electric furnaces of the bottom heating type. Several tests were carried out on a furnace of the Greaves-Etchells type and not a single test showed any indication of marked difference in temperature between the top and the bottom of the bath and in every case it was shown that in a furnace of this type there is no need for any mechanical stirring of the bath. Considering the crudeness of this test and the fact that the rod had to be passed through a slag, the uniform effect of the bath on the bars were quite remarkable, both for baths that were relatively cold and hot.

Temperature Is Indicated by Fluidity of Metal.

The pouring test consists of using a spherical spoon of above five inches diameter and carefully slagging up this spoon over the bath. Dip the spoon quickly into the metal so as to get a sample of the steel from about the center of the bath. Withdraw the sample and carefully pour out the steel over the lip of the spoon at a slow even rate. The temperature of the steel is noted by its fluidity, and by the amount of steel skull that is left on the spoon. This test is the one most commonly used in steel foundries. It is simple and the very nature of the test gives confidence to the man who is responsible for pouring the heat. If he sees every drop of the steel pouring nicely over the lip he feels that in pouring from the ladle itself the castings of small section will fill up and there will be no skulls left in the ladle. This test is subject to the spoon being properly slagged up, the rate of pouring the sample, and absence of drafts.

For all these practical methods too much emphasis cannot be placed upon the fact that they are all comparative tests only, and that they depend entirely upon uniform conditions, and attention to details. In all cases at least two of these methods should be employed. They do not of course indicate to the melter the temperature of the steel in degrees, C. or F., but they do give him a very good indication of the degrees of temperature that the steel is either above or below the temperatures which will give him the best results for the composition of the steel he is handling, for the weight and for the type of casting he is making. In making steel castings it is important that the foundry foreman or superintendent be present when the final temperature tests are being made. He is in a much better position to know how hot the steel must be to suit the castings on the floor. To tell the melter that the castings are averaging 30 pounds and then to leave the decision regarding the temperature up to him, is not sufficient.

The question most frequently asked while trying out the above tests was: "How accurately can you measure the temperature of the steel and what temperature should the steel be when it leaves the furnace to give the best results?" The first part of the questions refers to the use of the pyrometers. On steel works where the best conditions for the pyrometer can be obtained, there is still the limitations of the pyrometers themselves. As already explained, only the optical and the radiation type offer a good field for these high temperatures and conditions, and there is little doubt that an error of plus and minus 50 degrees F. in the instrument itself is all that we can ever expect. To an investigator first starting in with a new instrument he has just bought, this may not sound very encouraging as he naturally feels that if the steel proves to be 50 to 100 degrees F. less than what he is aiming for he will spoil some of his castings. The other limitations of focusing and atmosphere have already been described and values given.

Determining Best Temperatures.

Probably the best reply to the second part of the question is that the temperature in question is that at which the particular steel begins to solidify, plus the loss of temperature from when the reading is taken to when the steel gets to the farthest end of the thinnest section in the casting. A further query to this second part of the question invariably was: "But how are we to know what these two values are?" The first value depends on the composition of the steel, the carbon contents being the principal factor. This can be obtained by reference to a standard carbon-iron curve, such as shown in the accompanying illustration. For a steel containing 0.25 per cent carbon, trace the line A B till it intersects at C giving a value on this curve of 1,492 degrees C. (2,720 degrees F.); for a steel containing 0.65 per cent carbon, trace the line DE till it intersects at F, giving a value 1,476 degrees C. (2,690 degrees F.), and so on. For other elements in the steel commonly used in castings the variation is not of importance and does not compare with the many other sources of error that crop up in reading the temperatures of molten steel in a foundry. The second value depends upon such variables as the heat of the ladle, the thickness of ladle lining, time of reading to pouring, whether molds are of dry or green sand, and thickness and lengths of the thinnest sections. All of these factors depend very much upon local conditions, and it is regarding this problem that constant consultation between the man responsible for the steel in furnace and the man responsible for making up the molds is so valuable. Final results are only obtained by the constant comparison of the quality of the final castings with the results obtained by their methods of reading the temperatures of the steel.

Some Large Steel Plant Thermit Repairs

Repairs Prevent Delays in Operation—Interesting Report of Shear Casting on Which Accurate Allowance for Contraction Was Made—Other Repairs Illustrated.

The accompanying illustrations show some recent thermit repairs of unusual size which have played an important part in preventing the tying up of steel plant production, in addition to adding years of service to the sections welded.

A repair, remarkable for the accurate allowance for proper contraction of the metal comprising the weld, especially so for a cast iron section, is shown in Fig. 1. This is a 156 inch plate shear, knife head casting welded by J. H. Baker of the Brier Hill Steel Company, Youngstown, O. That exact contraction allowance was anticipated was shown by the fact that after welding, the head was put in place and bolted up just as it was originally without having to ream the holes and make new bolts. As shown by the sketch, the break measuring 40 inches in length, ran diagonally through a casting varying from 3 to 10 inches in thickness. One thousand two hundred pounds of cast iron thermit were used for making the weld.

Fig. 6 shows another cast iron weld made on a cast iron housing for the National Metal Molding Company, Economy, Pa.

The following three illustrations show three suc-

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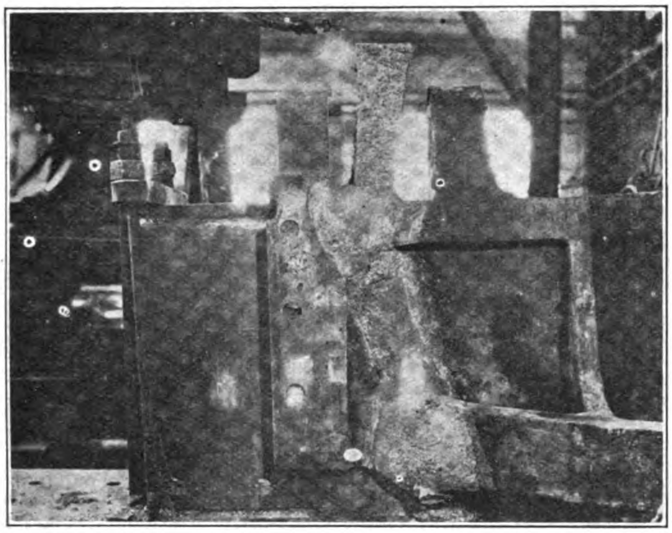

Fig. 1—Plate shear knife head casting.

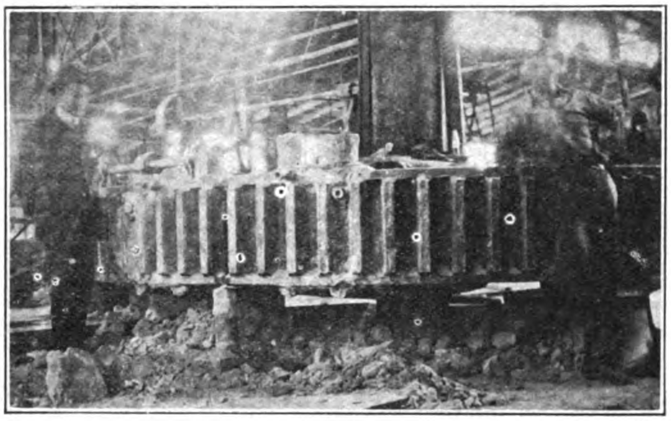

Fig. 3—Location at break in gear wheel.

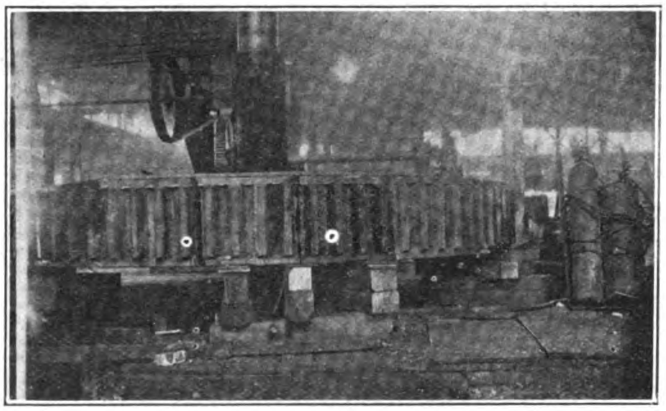

Fig. 5—Finished weld on gear wheel.

cessful thermit repairs of unusual magnitude recently executed in two places in a gear wheel for the Canonsburg Steel & Iron Works, Canonsburg, Pa. The gear wheel welded was 15 feet in diameter and its face 23 inches wide.

Fig. 3 shows the location of the break in the gear wheel. Figure 2 shows the large mold box which was constructed around the breaks, with three large automatic crucibles having extension rings suspended over the mold box ready for pouring the thermit steel. Fig. 5 shows the finished welds. One thousand pounds of thermit were used for each weld, making a total of 2,000 pounds. Fig. 4 shows two 350 pound thermit welds made on a large broken trimming frame for the American Car & Foundry Co., Berwick, Pa. The cross section of the breaks were 6x14 inches. At the time the weld was made the housing was laid flat on its side, instead of in its vertical service position, as shown in the illustration.

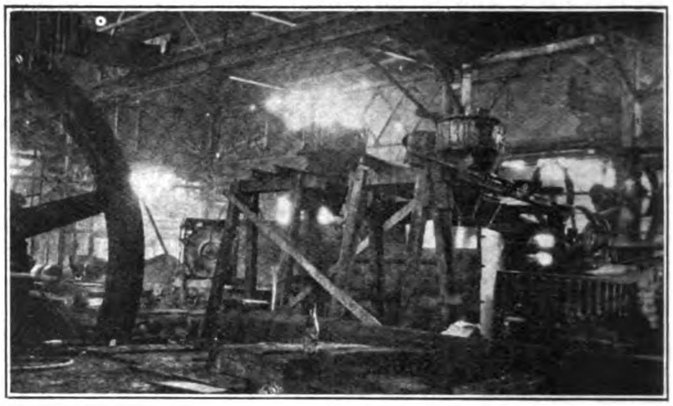

Fig. 2—Mold box placed around break (Fig. 3).

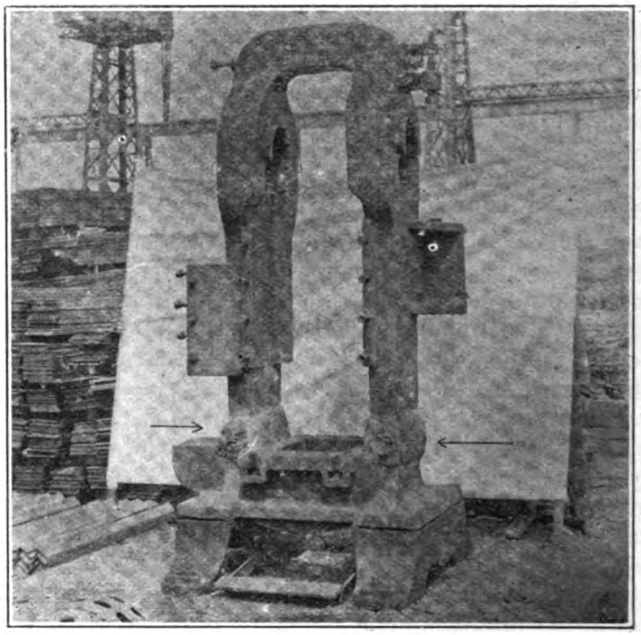

Fig. 4—Weld on trimming frame.

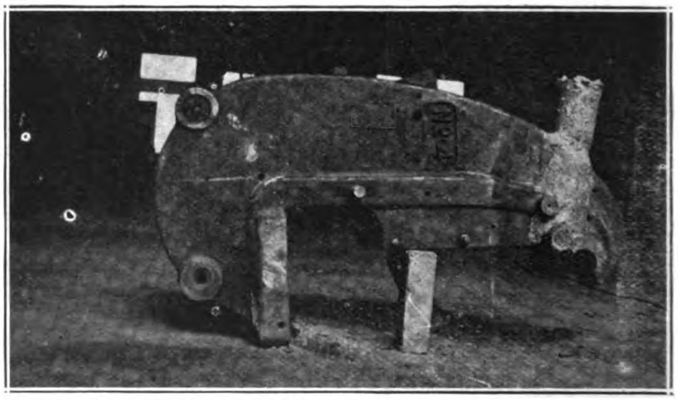

Fig. 6—Cast iron housing repair.

Manufacture of Light-Wall Steel Tubing

Specialty, Brazed and Seamless Tubing Discussed—Mannesmann Process of Making Seamless Tubing — Stiefel Process — Cold Drawn Seamless Tubing—Testing and Inspecting.

By H. J. FRENCH.

Within the past few years, particularly because of the rapid growth of the airplane industry during the war, considerable attention has been paid to the manufacture of light-wall cold-drawn seamless and welded steel tubing for structural purposes. While the manufacture of such tubing is not, in itself, a difficult matter, some difficulties have been encountered in producing the same under specifications requiring definite physical properties. It is the purpose of this paper to describe the methods of manufacture and the properties that may be obtained by such methods for tubing coming within about ½ to 2 inches (12.7 to 50.8 mm.) outside diameter and 10 to 22 Birmingham wire gauge (0.134 to 0.028 inch wall thickness). Such tubing is largely used as structural material in the aircraft industry, and it is of the utmost importance that the physical and chemical properties should be known, and also that the various factors entering into the manufacture should be under such control as to allow these properties to be varied and held within definite limits.

In general, tubing may be divided into four classes: namely, specialty tubing, such as riveted-sheet or plate, lock jointed, etc.; brazed tubing; welded tubing; and seamless tubing Welded tubing may be divided into hot product, such as lap welded and butt welded, and cold product, such as acetylene and electric welded. Seamless tubing may be hot rolled or cold drawn.

Specialty Tubing.

The first two classes present mainly mechanical or structural engineering problems. A simple form of tube is made by riveting together the overlapping edges of rolled sheets or plates formed into a cylinder. Because of the nature of its construction, such a tube is necessarily limited to relatively large sizes. Lock jointed tubing is produced by passing law-carbon strip through a forming machine having suitable rolls and dies, its manufacture is almost entirely a question of design of the forming machine and its satisfactory operation. The chief application of such tubing is in the manufacture of bedsteads.

Brazed Tubing.

Production of brazed tubing presents no special difficulties, though the application of metallurgical principles is involved in the application of a correct brazing mixture and proper heating. A simple method of manufacture consists in forming the tube from strip in a machine having a series of rolls with properly designed holes of successively decreasing radii and then passing the formed strip at a uniform rate under a funnel-shaped device, which feeds the brazing mixture directly onto the line where the two edges of the strip meet. The tube is later passed endwise through a heated muffle by means of grooved racks traveling on an endless chain, which passes through the heated chamber and, on the return, is passed through a trough of water for cooling.

Seamless Tubing.

The maunfacture of seamless steel tubing, the most important type for structural purposes, is of comparatively recent origin, beginning little more than 25 years ago. Its development has been accelerated by the bicycle, the automobile, and the airplane, the latter creating a demand for a most refined and closely controlled product.

The conversion of a solid piece of steel into a seamless tube may be accomplished by boring a hole in the center of a round steel bar, by forming sheet or plate between a series of suitable dies, and by piercing by the Mannesmann process or one of its modifications.

The first and oldest method consisted in merely boring a hole through the center of a long round bar; besides being a laborious operation and very difficult to perform, this was expensive. Various modifications to simplify this method of production may be used. A hole may be bored through the center of a short bar, which may then be drawn out cold; or the hollow bar may be placed in a hydraulic press and the hole enlarged by forcing into it successively larger rams after which the tube may be rolled out over a mandrel in a manner similar to that by which lap-welded pipe is rolled. These modifications are easier to carry out than the original method and much less expensive. Other modifications may also be used depending on the character of the product desired.

The second method is used for the manufacture of gas containers and consists in pressing a heated flat circular plate between a series of dies. In this process the depression successively becomes deeper until finally the sides of the cup formed are parallel. For light-gauge sheet, this cupping may be performed cold in three or four stages and the tube thus formed, with one closed end, may be finally drawn out in the ordinary manner, which will be described later.

Mannesmann Process of Making Seamless Tubing.

The most important method of producing seamless tubes is in the Mannesmann process or modifications of the principles involved. The underlying principles of this process were first applied by the Mannesmann Brothers, German tool-steel manufacturers, and today practically all light-wall, cold-drawn, seamless, steel tubes used in the aircraft industry in America are made from hot-rolled billets pierced in this way.

Paper read before September meeting of A. I. M. M. E.

Hot-rolled rounds of suitable composition, usually from 3 to 6 inches (7.5 to 15 cm.) in diameter, commonly called billets, are hot sawed into proper lengths depending on the length of tube desired. These lengths are then heated in ordinary heating furnaces and fed to a pair of conical rolls set at an angle to each other, as shown graphically in Fig. 1. The bar, which is at a bright red heat, is rapidly rotated as it enters the small diameter end of these rolls, which exert a pressure on two constantly changing points, but which are always on opposite sides of the center, or axis, of the bar. During the first few inches of longitudinal travel imparted to the bar, a flaw, or point of weakness, at or near the center is formed. The action of this part of the rolls may be likened to the effect of pressure exerted by flat dies in a hammer when applied to a round bar heated to normal working temperatures. Under such conditions, there is a tendency for the metal to spread outward from the center instead of being compressed by the blow. As the bar is pulled forward between the rolls, it reaches the section of larger diameter, where the linear speed is greater than at the small end of the rolls. There is, therefore, a tendency to twist the outer surface of the bar, which is also pulled forward. This intensifies the weakening effect at the center of the bar, and as the bar is lengthened more rapidly than it decreases in diameter, metal must be drawn from somewhere—which will naturally be the weakest point or the center of bar. As the bar is leaving the rolls, it is forced over a piercing head at the end of a strong heavy rod which completes the formation of the tube. The tube is removed from this rod, and a new head is placed on the same preparatory to piercing the next bar. Because of the shape of the rolls, this equipment is often called a barrel-type mill.

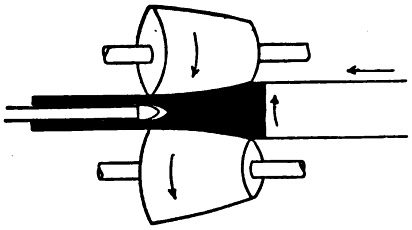
Fig. 1—Mannesmann process.

Stiefel Process.

The disk-type mill, or Stiefel process, graphically represented in Fig. 2, is also used in forming tubes by the application of external pressure.

The pierced billet, or tube formed, is rough and has heavy irregular walls. Further reduction is therefore necessary, so the tube is again heated and fed to a pair of rolls which are grooved as for rolling round bars. In back of each opening is a mandrel, which has a loose nose and is carried by a strong cross-bar attached to the housings at the back of the stand. As the tube is passed through the rolls and forced over the mandrel, it is reduced in outside diameter and wall thickness, the latter being determined by the size of the mandrel. This first stand is usually referred to as the breaking-down rolls. The tubes are then usually reheated and passed to the finishing rolls; if further reduction is desired, they may be passed directly to a reducing mill, consisting of a series of rolls alternately rotating about horizontal and vertical axes. The size of hole from the first to the last set of rolls decreases so that the tube is decreased in outside diameter.

The hot-rolled pierced billets are reduced to varying sizes and wall thicknesses down to about 1¾ inches (4.5 cm.) outside diameter and ⅛ inch wall. They are next passed to the cold-drawing mill, where they are pickled, washed and dried, drawn, annealed, and again pickled, the cycle of operations being repeated as often as necessary to produce the desired size and gauge in the cold-drawn tube.

For pickling, a dilute hot acid is used. In place of the more generally used sulphuric acid, some plants use solution of niter cake, which is a by-product from the manufacture of nitric acid. When hot, this solution does not give off the obnoxious fumes obtained from the use of sulphuric acid and the relatively weak concentration of the acid radical decreases the danger of over-pickling. In either case, some of the scale is dissolved and the remainder loosened so that it readily comes off in washing. After removal from the pickling bath, the tubes are washed, dipped into lime water, and dried. Before being cold-drawn, they are pointed at one end by means of a drop hammer or other device.

The draw-bench consists, primarily, of a long heavy frame on which is mounted, by suitable means, an endless chain, which extends from one end to about the center and which slowly travels toward that end. The tube is threaded over a mandrel or bar and the pointed end is passed through the die, which is attached to the fram near the center of the bench. The pliers of the draw box are attached to the pointed end of the tube, the box is attached by a hook to the slowly moving endless chain, and the tube is drawn out, as shown in Fig. 3. Grease or tallow is used as a lubricant.

Cold-drawn Seamless Tubing.

In cold drawing a tube, one of three methods may be used: (1) Drawing through a die without the use af mandrel or rod, called "sinking." (2) Drawing over a mandrel and through a die, referred to as the "back-bench method." (3) Drawing on a rod through the die. The first method obviously reduces only the diameter of the tube. The second and third methods accomplish the reduction of the outside diameter and the wall thickness. In the back-bench method, the tube is pulled over a mandrel at the end of a long bar attached to that end of the draw bench from which the tube is pulled. As the mandrel is fixed, both the inner and outer surfaces of the tube become friction surfaces in the drawing, and the tube takes the entire "pull," which is

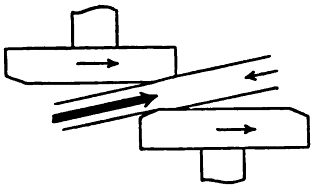
Fig. 2—Stiefel process.

limited to that force which would break the thin wall of the tube.

In the third method, the tube is threaded on a rod that has been cold-rolled, drawn, or machined to a uniform diameter, and the two are drawn together through the die. In this case the tube has but one friction surface, and the "pull" is taken by the bar of very much greater cross-sectional area than the thin-wall tube, which sustains the force applied by the second method. As would be expected, greater reduction per pass can be used when drawing on a rod, and it is possible to reduce a tube a given amount in outside diameter and wall in fewer passes than by the use of the back-bench method.

After drawing, the tube is tightly attached to the rod, so special means must be taken to remove it. This may be done by passing the rod and attached tube a large number of times through a pair of rolls having a groove of larger radius than the outside diameter of the tube. With each pass through the rolls the tube is rotated slightly so that the line of contact is changed. The pressure applied lightly reduces the wall thickness of the tube, which is accompanied by expansion, so that it is possible to remove the parallel mandrel with ease. Another method of releasing is to pass the tube through a "reeling" machine, which consists primarily of a pair of conical rolls revolving in the same direction, the axes of the rolls being inclined to the horizontal in opposite directions. The details of this machine will not be given, its action being to slightly reduce the wall thickness, which is accompanied by expansion in the diameter. After one pass the mandrel may readily be removed.

Testing and Inspecting Seamless Tubing.

After the final pass, which brings the tubes to the desired size and gauge, they are annealed at a comparatively low temperature, depending on the analysis, amount of cold work, and desired properties. They are then straightened and the ends cut off; if special lengths are desired, they are cut to these lengths and inspected. The inspection made varies considerably, depending on the specifications, which, in turn, are based on requirements for the particular purposes for which the tubes are desired. For the type of tubing under consideration, the inspection may be considered to consist of a thorough visual examination of the tubes, including a check on the size and gauge and the determination of the chemical and physical properties.

For physical test, a number of tubes from a batch are chosen and a sample about 14 inches (35 cm.) long is cut from each tube. Usually one sample tube is chosen for each 400 feet (122 m.) of tubing presented, though this number is greatly increased when a question regarding the uniformity of the lot arises. Marks 1 inch (2.5 cm.) apart are scribed over practically the entire length of the sample along two lines approximately 60 degrees around the circumference of the tube, which is placed in the testing machine after the insertion of slightly tapered solid plugs in each end. The pulling head of the testing machine is brought to such a position that the jaws take hold of the tube with the contained plugs at a distance of about 8 inches from each other and the load is applied at a uniform and slow rate, not exceeding 0.50 in. per minute. The yield point is obtained by calipers scribing a line of about 5 inch radius and noting the load causing a permanent set. This method requires the release of the load and its reapplication; but when experienced the operator can usually make this determination without releasing the load more than once. Having determined the yield point, the rate of application of load is increased to about 0.80 to 1.0 inch per minute to break the tube. The elongation is measured in the usual manner, except that the maximum readings of the two original 2 inch and several possible 8 inch gauge lengths, including the break, are the values taken.

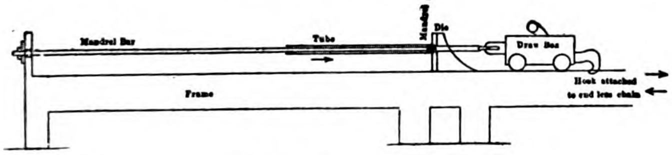

Fig. 3—Draw bench.

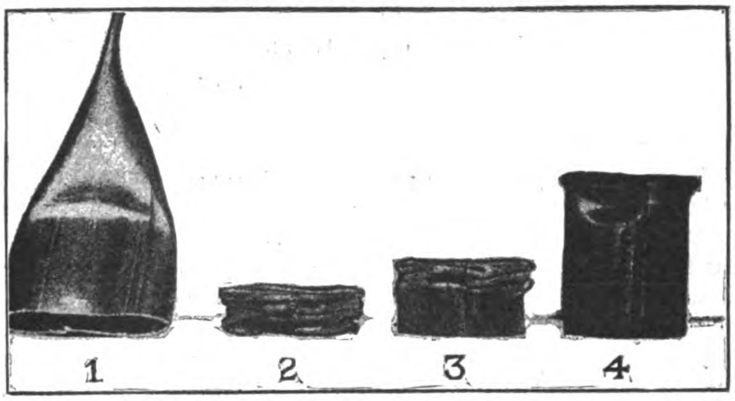

Fig. 4—Results of flattening and compression tests. 1, flattening test made on a welded steel tube; 2, 3, and 4, different stages in compression test made on a section of welded steel tube; 2, complete compression; 3, three complete folds; 4, compression for given percentage expansion in diameter. Note failure in the weld of all tests shown.

While the elongation in the tensile test is measured, two other tests are largely used as a measure of the ductility. The compression test consists in the application of pressure parallel to the axis of the tube on a sample whose length is 1½ times the outside diameter. Specifications usually require that the tube, in such a test, shall not show cracks when the diameter has been increased to a given per cent or when one complete fold has formed. However, the test is often carried beyond this specified expansion to the point of failure, which is measured in per cent increase of the original diameter. The second test for ductility is the flattening test, in which pressure is applied to the tubes perpendicularly to the axis of the tube until the walls are at no greater distance from each other than twice the thickness of the wall of the tube; under such conditions the tube must show no cracks. Fig. 4 shows the character of these tests. Obviously the compression test is more a measure of the ductility of the tube at right angles to the direction of cold work while the flattening test is a measure of the ductility with the grain of the metal.

Future Improvements in Open Hearths

Questions Regarding Efficiency of the Open Hearth Furnace Taken Up—Lessening Quantity of Inclusions—Is the Objection to the Use of Ore Justified?

By HENRY M. HOWE.

The efficiency of the open hearth furnace depends in large part on that of the regenerators regarded as heat filters. Our present ones seem very crude, having for instance about the same construction in their upper as in their lower parts, though the heat conditions differ so enormously from top to bottom. We may well ask whether the passages should not be larger above, where the gases are so greatly expanded, than below. Further, whether the bricks themselves may not be improved. They catch and emit the heat at their surfaces only, but store it in their interiors. Hence their surfaces should be extended, and their materials should transmit heat readily from surface to interior and back. This latter calls for a dense, and perhaps even a semi-glazed state. A hard brick of great conductivity, even if too fusible for the upper part of the checkers, might well be used in the lower part. Again, the extent of surface might be increased first by making the bricks very thin, and second by ribbing their sides with vertical ribs that would not catch the dust.

The efficiency of the furnace depends further on the accurate retention of the shape of certain parts, for instance the ports and valves. It may be well to inquire carefully in what parts of the furnace the advantage of accurate retention of shape by means of water cooling outweighs the loss of heat involved.

For moving the incoming and escaping gases, how does the profit from using fans compare with the cost of their installation and operation:

We may ask what the actual profit is from the use of fans for moving the incoming and the escaping gases, after deducting their cost. Their use thus far is promising. I introduced them for both purposes in 1874.

We may ask what the useful limit of size of the furnace itself is, the limit where the disadvantages of irregularity of temperature and composition, and of excessively great units for soaking and rolling outweigh the advantage of saving of fuel, labor, and installation per unit of product. This limiting size will be greater for quantity than for quality practice.

How should the pitch of the ports be related to the lengths of the furnace, to the kind of fuel, and to the stock? Flatter ports might be needed for charges rich in scrap, which have to be protected from oxidation during melting, than for molten pig iron which has to be oxidized vigorously.

How deep should the bath be at its deepest point, first so that it may work as fast as is consistent with thorough control over it; second, that we may gain the economy of large charges?

Turning now to the open hearth process itself, we find many matters pressing for attention. Perhaps our greatest need is to impress on our operators the extreme importance of controlling the composition of the slag, and especially of lowering its iron oxide. Precise maxima of iron oxide permissible for various processes and grades of steel should be established, and should be incorporated in all important contracts. quite as rigorously as the permissible for various processes and grades of steel should be established, and should be incorporated in all important contracts. quite as rigorously as the permissible sulphur and phosphorus contents of the steel itself.

The methods of lessening the quantity and harmfulness of inclusions need great improvement. Three essentials seem to be, first, ample time for the inclusions to rise by gravity in furnace, ladle, and perhaps mold; and second, fusibility of the oxides formed by the final deoxidizing additions, so that they may readily coalesce into particles large enough to rise rapidly. As a step towards this last we should determine systematically the melting points of the combinations of oxides which it is practicable to form with these additions.

The quiet which results from thorough deoxidation of metal and slag may be held to have two simultaneous but opposite effects. It facilitates the rising of inclusions of given size, but it does not favor the coalesence of particles into masses large enough to rise fast, as rapid movement does.

How far is the objection to the use of ore justified. We object reasonably to the use of rusty scrap because of the irregularity in the quantity of oxygen which this causes. In treating charges containing any considerable quantity of pig, much oxidation has to be done. Some very competent men would have this done wholly by the furnace gases, and object to the use of ore apparently on the ground that the resulting local over-oxidation is not readily overcome. They would have the oxidation superficial, brought about by the slag rather than by iron ore submerged in the bath itself. The evidence should be examined with care. We should not be led away by unsupported theories however plausible. Certainly the excellence of the acid open hearth steel made with moderate use of ore sets up something of a prima facie case for oring.

Should residual manganese be insisted on in making fine steel, and in general that on which human life depends? The demand for it rests on the belief that oxidation by means of manganese, acting as a carrier

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From address before fall meeting of American Iron and Steel Institute.

of oxygen, is beneficial in that it does not lead even to the temporary formation of iron oxide within the metal. This should be tested more thoroughly. If true, then the benefit of this treatment should cause some special merit in the product in the way of a specially high combination, for instance of elastic limit and ductility or shock resistance, and the specifications might be amended so as to reject steels which lack it. I refer of course to steels for important purposes, failure in which would endanger life.

The relative merits of the basic and acid open hearth processes should be established more firmly. The comparison should be made between the two practiced under truly comparable conditions, for instance with nearly equal strength of deoxidizing conditions, and not between basic with 80 per cent of pig iron and acid with only 25 per cent.

The advantages of the dominant pool of the Talbot process should be evaluated, so that they may be weighed against the disadvantage of having to make the steel in the ladle. Do we really gain enough time by leaving part of the charge in the furnace to overcome the objection to ladle steel-making, with its irregularity of composition?

We should satisfy ourselves that our American practice of using a low casting temperature for fine steel casting instead of the high temperature used in Continental Europe is right, and ask searchingly whether its advantages of giving freedom from surface cracks and of restraining both axial segregation and the coarseness of the columnar crystallization really outweigh its disadvantage of giving less opportunity for the inclusions to escape in the ladle.

The relative advantages of limestone and lime should be weighed. Limestone is a cheaper material than ore for bringing on a boil, and with it we avoid introducing iron oxide into the molten metal as ore does, thus substituting superficial or slag oxidation for internal or submerged oxidation by the immersed ore. On the other hand it is derided as using the costly heat of the open hearth to do the work of the cheap heat of the lime-kiln. How does the extra cost of this heat compare with the alleged advantages?

Turning now to the compound processes, including the duplex, triplex, Bertrand Thiel and others, we may divide each into a roughing and finishing phase. The chief reason for their existence is to separate the silica formed by the oxidation of the silicon of the pig iron from at least the last part of the dephosphorization. Hence they seem applicable primarily when an abundance of pig iron is to be treated. They hold out additional advantages in the way of a rapidity and cheapness at least giving directly and cheaply to blown Bessemer metal some approach to open hearth or electric quality. Beyond this they can be used for making alloy steels in an electric furnace directly and relatively cheaply out of molten open hearth or conceivably even out of Bessemer metal. These advantages are to be weighed against their inevitable large loss of heat in transferring from one furnace to another.

For the roughing phase the Bessemer converter, both acid and basic, the basic open hearth and the basic lined mixer are applicable for the finishing phase, the basic open hearth and the basic electric furnace.

Among their additional advantages are first, their concentrating the phosphoric acid in a relatively small quantity of slag, which may be useful as a fertilizer even when the stock contains relatively little phosphorous; second, their use for making alloy steels directly and relatively cheaply from molten open hearth or conceivably Bessemer metal, and third, their improving the quality of molten blown Bessemer metal by treating it directly and cheaply in the open hearth or electric furnace, thus getting part of the cheapness and rapidity of the Bessemer process together with a quality at least approaching that of open hearth steel.

These advantages are to be weighed against the inevitable serious loss of heat in transferring from one furnace to another, and the total loss of the initial manganese in the roughing phase compelling us to replace it in the finishing phase if we are to have the benefit of residual manganese.

For the roughing phase the Bessemer converter, both acid and basic, the basic open hearth, and the basic lined mixer are applicable for the finishing phase, the basic open hearth and the basic electric furnace.

Here we should study the relative advantages of the three roughing furnaces and of the two finishing ones.

In using the Bessemer process for roughing we usually blow about two-thirds of the pig iron very full and the remaining third, or "kicker, only half way, to the end that the carbon left in the kicker, about 1.75 per cent, may react vigorously on the iron oxide stored up in the full blown metal, and bring on a boil. This full blowing wastes iron, time, and steam, so that the resulting oxide is extremely expensive. We should satisfy ourselves whether its convenience justifies its use in place of iron ore or scale. Beyond this costliness, we may ask whether here, as in Bessemer practice in general, we do not sacrifice quality unduly to the convenience of having a clear signal for ending the blow, remembering here how the Swedish Bessemer steel caught on the way down compares in reputation with our full-blown product.

We should ask further how far the damage to quality due to Bessemerizing is remedied in the finishing process, and how this finishing must be done to make this remedy effective. If this damage represents simply imperfect deoxidation of the iron and imperfect removal of inclusions, the general direction of the remedy seems clear.

Of the two other roughing furnaces, the mixer and the open hearth, the mixer seems to lend itself to the treatment of pig iron too rich in silicon for the open hearth, and the open hearth to the treatment of relatively low-silicon iron. We should seek clearer definition of the conditions appropriate to each of these two furnaces, and should ask what advantages the open hearth has over the mixer to compensate for its higher operating cost, due to its smaller scale of working and its more intricate construction.

Again we should ask how far it may be possible to reduce the disadvantage of the Bessemer, its loss of iron, while retaining its advantage of rapidity and cheapness.

Coke Oven Gas Reheated Improvement

Increasing Utility of Reheater by Application of Radiator Plates of Corrugated Sheets. Wide Range of Applications to Indirect Cooling and Apparatus.

By GEORGE B. CRAMP.

In the October and November issues of THE BLAST FURNACE AND STEEL PLANT there appeared detailed descriptions of the process of by-produc ttar recovery, the apparatus used and suggestions for improvement of design and construction for increasing efficiency of the apparatus was discussed.

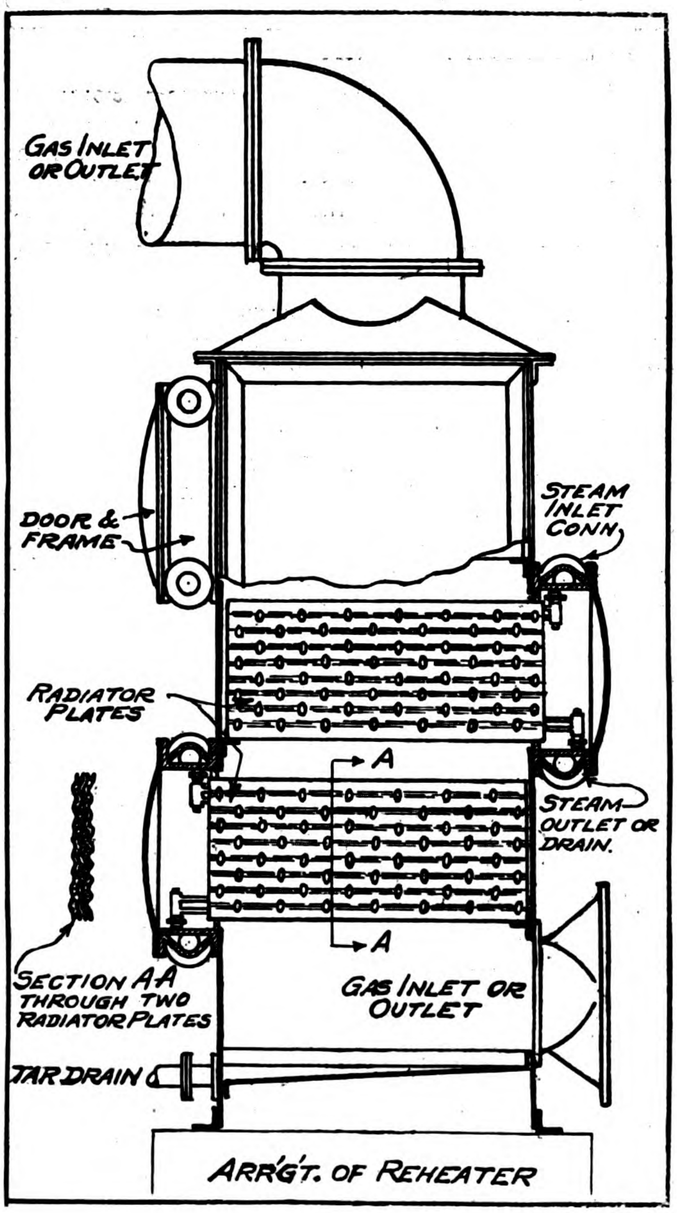


Fig. 1.

The October issue contained a description of the primary cooler, the function of which is to cool or condense the gas to a temperature sufficiently low to cause the tar and some ammonia vapor to condense and precipitate in the form of liquid tar and ammonia. The gas is drawn from the ovens through the cooler by the power driven exhauster which forces the gas under pressure through the various recovery apparatus, the first of which is the tar extractor described in the November issue.

After passing through the tar extractor the gas should be free of practically all tar and is ready to be passed through the saturator for the recovery of the uncondensed ammonia vapor yet remaining in the gas in the form of ammonium sulphate.

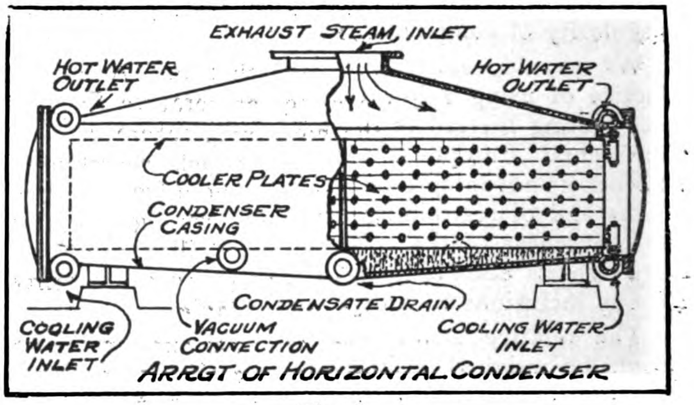


Fig. 2.

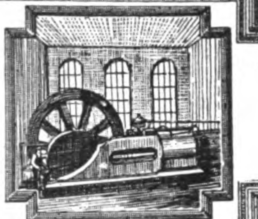
In most processes of recovery, however, the temperature of the gas has been reduced to a temperature so low—in order that tar precipitation may be complete—that the gas requires reheating before entering the saturator if the operation of ammonia recovery is to be efficient and complete.

The form of apparatus usually used for reheating the gas greatly resembles a vertical fire tube boiler. The gas enters either at the bottom or top of the reheater or what to the vertical boiler would be the firebox and the smokebox respectively. The gas passes through the tubes of the reheater but instad of generating steam, as do gases of combustion in a tubular boiler, the gas absorbs heat from the inside of the tubes radiated from the exhaust or low pressure steam injected into the tubular compartment. The reheater therefore is of the indirect type of apparatus in accordance with the classification of apparatus described in last month's issue on the tar extractor.

Probably no piece of recovery apparatus is given so little consideration in the design and detail as the reheater. The tubes which form the heating surfaces are usually of large diameter, the gas, passing through them without coming into intimate contact with the inside tubular surfaces in

(Continued on page 616)

STEAM POWER DEPARTMENT



Saving Coal in Steel and Tin Plate Works

Suggests Proceeding Along Plan Which Enables Fuel to Be Saved With Reduction of Labor and With the Least Increase in Capital and Reduction in Complications of Waste Heat Plant.

By J. E. STEWART.

The question of fuel economy is at last being much discussed, and from various points of view, but principally with the object of utilizing waste heat. A few remarks may lead to a discussion that may be of service to those considering this subject, and may possibly help some to come to a conclusion after weighing the advantages between the two points of view which I propose to state.

The above and the following was written to *Engineering* by J. E. Stewart, under the title of "Coal Saving in Steel Works and Tin Plate Works."

The utilization of waste heat means very large capital outlay, rearranging of plant and restricting the freedom of layout, and the more serious trouble of increased labor and corresponding weakness owing to sectional strikes. The best direction to proceed, as I see it, is that which enables fuel to be saved with reduction of labor and corresponding increased freedom from troubles arising from labor, and with the least increase in capital and reduction in the complications inherent in any scheme for the introduction of waste heat plant. In these notes I propose dealing with steel works and tinplate works only.

Taking steel works rolling, say, tinplate bars, about 9x⅝ in. The process is commonly as follows: Coal is used for producer gas to supply the melting furnaces. After running metal into ingots, the latter are placed in soaking pits, also provided with gas to heat them and maintain them at the best temperature for rolling.

Next, coal for boilers to work chargers, cranes for handling ingots to and from soaking pits; cogging and finishing (engines usually exhausting to atmosphere); auxiliary machinery such as shears, bar-cutters, live rollers, pumps, etc. In this latter I only propose to deal with the power side of the proposition.

The coal used in producing steam to drive cogging engines, finishing engines and auxiliaries, including electric light, may be taken as 360 lbs. per ton. This figure is the mean of the results at three works turning out nearly the same bar from the same sized ingot.

The result of two works turning out similar bars, but driven by electricity, No. 1 taking their electricity supply from a central supply and No. 2 from their own station, are tabulated below. The energy from the works drawing their supply from the central supply company is considerably more economically worked. The results are:

	No. 1 Energy from Public Supply. Units.	No. 2. Private Plant. Units.	Mean Units.
Roughing	9	12	10.5
Finishing	24	33	28.5
Electric light and auxiliaries	7	7	7.0
	40	52	46.0

Converting the energy into coal consumption at 3.5 pounds of coal per unit delivered at the motors, would result in a consumption of 140 pounds per ton, 182 pounds per ton and 161 pounds of coal per ton, respectively, or a saving in coal consumption in each case of 220 pounds, 178 pounds and 199 pounds, showing that as much coal can be saved in this manner as would be saved should all the waste heat be satisfactorily utilized. Moreover, this mode of driving simplifies the works in several ways, but principally by doing away with the boilers for steam generation, and consequent extravagant week-end labor costs. There are no restrictions in arranging the layout plant; maximum speed is maintained and consequently a better article is produced. There are no losses of speed and output due to variation in boiler pressure; condensing and feed-water troubles are eliminated, and there are reductions in the expense of carting ashes and providing dump land. Rolls cannot stall, as unlimited (practically speaking) power is behind the motors. Power can be cut off if not required and started without loss of time. Allowing for loss of time, stoppages would cause the energy consumption of the private plant to be much higher than that supplied by the central power, as they cannot shut off boiler power at a moment's notice, and there is not the incentive to economy when the supply is their own (which itself introduces further cost for wear and tear), as when energy is purchased. I am not at liberty to give the names of the works above alluded to, and this is a pity, as they are both to be congratulated on the results obtained.

Extensions can also be made with freedom, and instead of investing money in plant and machinery in a business which is outside that of making steel and rolling bars, it can be more profitably employed in the proper business for which the works exist.

Next as to tinplate works. "These works take the bars supplied by the above-mentioned steel works, and cut them into suitable lengths. They are then passed into a heating furnace; from this heating furnace they pass through the first set of rolls—"roughing rolls"—from which they pass again to a heating furnace, then through finishing rolls, and the plates are doubled. They are again passed into the furnace and reheated, and again through the finishing rolls, and again doubled This process continues until they get doubled into eights (in other words, the sheet, when it passes through the rolls for the last time is made up of eight laminations). They are then stacked by the mill-man on to his watch pile. From here they go to the finishing shears, and are then opened out (i.e., each lamination is separated). From there they pass to the pickling; this operation is usually carried out by mounting the separate plates into cradles actuated by power, usually steam, and douses these plates into a weak solution of acid. From the pickling, they are then stacked into annealing pots and placed in an annealing furnace (this process is called black annealing). On withdrawing from the annealing furnace, the plates are passed through cold rolls, the principal object being to prepare the surface of the plates for the ultimate tinning. After this process the plates are again annealed (called "white annealing"). Once more they pass through a second pickling. The plates are then ready for the tinhouse, the plates here passing through a bath of tin and flux, and are afterwards cleaned and made ready for the assorting table, and ultimately for packing into the boxes suitable for their size."

The coal consumed in tinplate works, taking the average of three works comprising one very large works, one medium size and one small, and stated in pounds of coal per box of tinplates, is as follows:

Power Lb.	Furnaces Lb.	Annealing Lb.	Tin and Scruff House Lb.	Total Lb.
63.20	32.25	22.60	12.79	130.84

The power includes rolling mills, bar cutters, shears, doublers, cranes, electric light and workshops.

The energy consumed by three electrically-driven mills, two driven by alternating current, one with direct pinion gearing, and one direct-current with rope drive, results in the following mean figures:

Rolling mills: 8.4 units per box of 20 to the ton; 1.91 units per box of 20 to the ton for auxiliaries; or a total of 10.31 units per box all in.

Allowing 3.5 pounds of coal per unit delivered to motors = 36.085 pounds coal, say 36.1 pounds of coal per box, while the lowest consumption per box recorded over a considerable period was 9.8 units at 3.5 pounds = 34.3 pounds of coal per box, as against 63.2 pounds, or a difference of 27.1 pounds of coal, and equal to 42.7 per cent saving in favor of the electric drives. A very great economy of coal can therefore be obtained by electrifying.

Of the three works mentioned, two take their supply of energy from a supply company, and in each case show a lower energy consumption than when the power is supplied from works plant. This economy can be obtained without interfering with the furnaces, etc., which are the outcome of growth of experience, and therefore dangerous to change excepting data after due trial and strict examination, and a sure and certain knowledge that such changes will be beneficial.

The reasons given as advantages favorable to electrification in steel works equally apply in the case of tinplate works also. I have not launched out into elaborate details, leaving that to grow if necessary out of any discussion that may arise, and upon information that may be volunteered as to running by other engineers.

Economical Operation of Mill Boilers

Sampling Contents of Ash Pit for Analysis—Training of Boiler Crew to Secure Economy—Notes on Instruments to Be Used in Boiler Plant.

By W. E. SNYDER

In the last issue of this journal the losses which take place up the stack were discussed, as they are by far the most important and their reduction will effect the greatest saving. The loss in the ash pit must be dealt with in different ways, depending on the type of equipment used. With hand-fired grates, about all that can be done is to have the air spaces in the grates as small as is consistent with proper air supply. I like best the herringbone bar, with the air spaces not over one-half or five-eighths inch wide. With flat grates the most of the unburned coal falls through near the front end, where it is often possible to scrape out some of this before the fires are cleaned, and fire it over again. With chain grates it is usual to extend

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Fourth installment of paper read by author before Engineers Society of Western Pennsylvania.

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the floor of the boiler room back under the grate about two-thirds its length, or put in reclaiming pans extending back this distance. All the unburned coal that falls through on this can be raked forward and refired. All the coal that is not burned out when it reaches the back end of a chaingrate is dropped over with the ashes and cannot be reclaimed, and it is for this reason that it is important to have coal used on chaingrates crushed fine, as is discussed above under Preparation of Coal.

It may not be amiss to say a word in regard to sampling the contents of the ash pit for analysis, to learn what the loss actually is. It is not possible to get a fair sample of a large quantity of mixed ashes and clinker. What I like to have done is to have all the clinkers of any size picked out with a hook and weighed separately. This is incombustible and does not need to be sampled. The remaining ashes, which will be mostly fine and easily handled, can be weighed and then sampled in the regular way. The combustible part which this contains can then be determined as a percentage of the total contents of the ash pit.

The loss of heat to surrounding air does not need any very extensive discussion as the proper remedy is apparent. This, of course, is to cover every part of the surface of the boiler, piping, valves, etc., with a good thick non-conductor. The use of insulating brick, as one vertical course inside the boiler wall which surrounds the hottest part of the furnace and boiler, would, I believe, be warranted by the heat saving which will result, though I have not had much experience thus far in their use. We have used such brick in the walls of other kinds of furnaces, and careful tests show that the heat radiated through the walls is only 50 per cent of what it was with the same kind of a wall without the insulating brick. In a boiler installation recently completed we find about the same reduction in radiation.

Training of the Men.

Having discussed above, the various heat losses which take place in operating boilers, it remains to discuss the application of this in the training of boiler house foremen and firemen. I believe the best way to begin this training is to prepare a typewritten or printed manual of instructions for boiler house foremen. These instructions must be given in clear and simple language, and then passed to the boiler house foreman by the superintendent or works manager, with the request that he study them carefully, in the expectation of being examined on them later. After the boiler house foreman has had sufficient time to become familiar, to the extent of his capacity with the instructions, an engineer or other mechanical man familiar with the subject must take up with the boiler house foreman these instructions in detail, explaining to him the points which he does not understand, and learning from him the particular kind of difficulties with which he has to contend in carrying out the instructions. The main purpose of all of this is to be sure that the boiler foreman understands what should be done to improve boiler efficiency, so that when conditions are not right, it will be known at once that it is due to carelessness and not ignorance, which it is very important to know in fairness to the men. This study by the foreman, with discussion following, must continue until he understands fairly well what is required.

After the foremen have received such preliminary training as has just been mentioned, the next step is to teach them more in detail about the proper handling of the fires. This is so that the foreman will be properly equipped to instruct the firemen verbally and by actual example as to what to do to keep the fires in proper condition. In this further instruction of the boiler house foreman, I believe one good method to follow is to equip one boiler in the plant completely with recording instruments and teach him the use of these instruments for the purpose of controlling the fire and the boiler. After the boiler house foreman has a good working knowledge of the curves drawn by the recording instruments, he should be required to rotate the firemen, so that the boiler equipped with the instruments will be under the charge of each fireman successively, for several days or a week at a time. While each man has charge of the boiler, he must be shown the effect of the different operating conditions as indicated by the curves of the instruments, and he thus gets at least a fair idea of what he is required to do in order to keep down the waste of heat.

The kind of instruments referred to, all of which are recording, are the following, considered as a minimum: A steam-meter, showing the rate at which the steam is leaving the boiler; a recording pyrometer, with the thermocouple located as explained by United States Bureau of Mines Bulletin No. 145; a draft-gauge, with one connection to the furnace and the other to the flue between the boiler and the damper; and a CO_2 recorder, which gives a fairly continuous record of the carbon dioxide in the flue-gas. These instruments are mainly for the purpose of reducing the loss up the stack, where the greatest saving can be effected. The contents of the ash pit from this same boiler should be sampled, and this result, together with those from the pyrometer and the gas analyzer, used in comparatively simple calculations to determine the total percentage of heat wasted, omitting radiation which is fairly constant from turn to turn. This gives a line on the actual results produced by the boiler, which is close enough for all practical purposes and can be posted for each turn in any form desired, to arouse the interest of the men.

In general, I do not believe in equipping each boiler, in a boiler plant of the kind under discussion, with a variety of instruments such as these mentioned. Such instruments are of no use whatever, unless they are kept in fairly accurate condition and the information which they give actually used in handling the fires. It is no small task to keep instruments of this kind in proper adjustment so that they will give reliable information and, when a number of boilers are completely equipped, the work of keeping the instruments in good condition can easily be out of all proportion to the benefits which result. It should be kept clearly in mind that such instruments are of no use whatever unless they have a favorable effect on the cost sheet. The owners of some boiler plants buy such instruments and have them installed for the same reason that some people give money to the church—they feel a sense of obligation to do something; they therefore seize upon the thing that is most convenient, and having satisfied their consciences pay no further attention to the matter.

Two examples of this have come to my notice within the last three months: Owing to the earnest efforts that have been made by the United States Fuel Administration, a great deal of interest has been taken in improving the operation of boiler plants, and the manufacturers of various kinds of instruments used in operating boilers have been very active. The representative of one such manufacturer gave us the names of companies using his instruments, and some written testimonials from these companies emphasizing the benefits which resulted. We sent an experienced man to investigate. He found the instruments installed all right, but some of them were not in condition to use; the boiler house foreman did not have clearly in mind what benefit was to be obtained by their use, and the firemen were handling the fires without any reference whatever to the instruments. In the other case, one of the inspectors aiding the United States Fuel Administration stated that the questionnaire from one plant indicated conditions so good as to warrant the maximum rating of 100 per cent. All boilers were equipped with various kinds of scientific instruments, stationary tube blowing apparatus, etc. He found later, however, on visiting the plant that neither the instruments nor the flue blowing apparatus had been receiving any attention at all, and were in such bad condition that they could not be used.

Therefore, I would repeat that when such instruments are installed in a boiler plant, they should be put in as forming part of the regular operating equipment of the plant and used in operating the boilers. If this cannot be done, they had better not be put in. The conditions about the ordinary boiler plants of steel works or blast furnaces are such that it is difficult to keep these instruments in proper condition, and it is better to have one boiler fully equipped and kept in condition and used for instruction purposes, than to have all the boilers partially equipped and allowed to get out of adjustment and become inaccurate so that the whole thing becomes a farce.

I would qualify the above discussion of instruments in this way: If I were installing a first class modern boiler plant of large units, say 800 or 1,000 hp each, I would consider very seriously the equipment of each boiler with instruments. In a high grade modern plant of this kind, the operating conditions are considerably different from what they are in the older plants with smaller units, discussed in this paper. The principle mentioned before should, however, be kept in mind in this case—that is, put in no instrument unless it is to be regularly used in the promotion of either safety, efficiency or reliability.

Comfort and Convenience.

Next in importance to better provision for safety and proper and systematic training of the operating men, are good working conditions. The boiler house ought to be made as comfortable as it is possible to make a place of this kind. There should be good light, both day and night, good ventilation and some attention should be given to keeping it warm and free from drafts in the winter. It may seem an anomalous condition to speak about warming a boiler house, but as an actual fact many times boiler houses are cold and drafty when the weather is cold. It must be kept in mind that, on account of the enormous quantity of air required to burn the coal when a number of boilers are in operation, the boiler house cannot be made tight; there must be provision for this air to get to the furnaces. The only proper way to deal with this condition of comfort of the men, is for some one who is familiar with operating conditions to make a careful inspection, both by day and at night.

It is necessary to make such provision for convenience that the work which the men do may be done as easily as possible; otherwise they will slight it as much as they can. For instance, furnace doors which have to be opened at intervals for firing or to inspect the conditions of the fires, should have wooden handles, and if these are not possible, the metal handles should be wrapped with wire-woven asbestos sheet, or other non-conductor. If it is not possible to inspect the fire through the doors, small inspection windows should be put in, made by running through the wall a two-inch pipe, with a glass window in its outer end. A piece of blue glass four or five inches long by 1½ inches wide, set in a frame with a handle on it, in the hands of each fireman, or a number of pairs of blue glasses distributed where they will do the most good, are, in my opinion, mighty good aids in handling the fires. The right kind of firing tools are also necessary. I have often seen firemen try to do their work with tools which were entirely unsuited for the purpose. Possibly the handles were too long, where the space is limited, and the handles were made of solid iron rods three-fourths to one inch in diameter, where light pipe would serve every purpose. Such things may seem like petty details, but I have seen so much wasted energy, due to lack of attention to these very things, that I know their importance is not always appreciated.

Many boiler plants in this section are fired with various kinds of mechanical stokers and chain-grates. In order to control the fire properly, it is necessary to change the speed of these machines. In making this change of speed often one of the worst conditions which exists is due to an arrangement of the driving mechanism, which permits the change of speed of several grates at the same time by the varying speed of the engine which drives them, and also an individual change of speed effected by changing the ratchets or points of connection of the driving-rod on each machine. This double provision for changing the speed makes it impossible for a fireman to know definitely what he is doing. For example, suppose he slows down the speed of one grate, by changing the driving ratchets. Some one comes along and slows down the speed of the engine driving this particular grate along with a number of others, and the result is a double reduction of speed on this particular grate. Or suppose the speed of the engine is increased by rising steam pressure or some other cause, the change which the fireman made in reducing the speed of one grate is partially or wholly neutralized by the increase of speed of the driving engine. Whatever the means for driving the firing mechanism or the grates adopted, the important thing to be kept in mind is that the speed of the grate for each particular boiler must be controlled independently of all others, and that the change of speed must be made at one place, and the fireman must know that the change which he makes will not be doubled or halved or completely neutralized by variations in the speed of the main driving shaft. If it is desired to have the speed of the main driving shaft changed by the operation of the pressure regulator, so that when the pressure rises the speed of all of the grates will be automatically reduced, this can be carried out all right and still maintain the conditions above mentioned. That is, the speeds of the main driving shafts will be changed automatically by the pressure regulator to suit the demand for steam, while the speeds of the individual grates will be changed by the firemen to regulate the condition of each particular fire.

The use of draft regulators is to be recommended where they are properly installed, and where the regulator will control the draft from the full effect of the chimney to a certain minimum, which is enough to keep the grate bars from burning. I have no use for a regulator which is either wide open or shut. The use of a draft regulator in boiler plants which have individual stacks on the boilers will mean quite a little actuating mechanism between the regulator and the dampers. If this is not put in properly, with ball-bearings for the damper shafts, and every possible care taken to make everything work freely and smoothly, good results will not be obtained. The installation may work all right for a few months or a year, but after a while the attention required to keep it in operating condition is such that it is out of use most of the time. When it is necessary to operate the dampers regularly by hand, the lever by which each damper is controlled must be placed within easy reach of the fireman, with a rod or rope running to the damper. If it is necessary for the fireman to walk to the rear end of the boiler and hang on to an old piece of rusty wire every time the damper is to be changed, it is a certainty that it will not be changed very many times during a 12-hour turn.

The water going to the boilers should be metered, and the meter should preferably indicate three things —the rate at which the water is being supplied at any particular instant; a curve recording this rate of feeding on a chart, and the total quantity of water fed in a definite period of time. The information given by such a meter is necessary to the regular operation of the boilers, and in giving the actual results produced by the boilers during the month in definite units on which actual costs of operation and fuel used can be based. I think it is also advisable to use the results from this meter at the end of each 12-hour period in a memorandum, for the superintendent of the works, which shows the number of boilers in operation and the average horsepower developed per boiler for each turn. This has the beneficial effect of insuring that only enough boilers will be kept in service to meet the actual demand for steam when operating at the capacity for best economy. (See paper by John A. Hunter on "Operation of Boiler Plants of Industrial Works," Proceedings of this society, Vol. 27, pp 287-318).

Instruction Manual—In the foregoing discussion emphasis has been laid on the necessity for definite training of the men who directly control the fires and boilers. For this instruction we must depend mainly on the boiler house foreman as the men are under his direct charge. In order that the boiler house foreman may instruct the men properly, he must first be taught by means of the methods suggested above, using a simple manual of instruction as a sort of textbook, and the question arises, what shall be included in this book?

It may be said that there are now several good pamphlets which have been prepared by the United States Bureau of Mines and other similar agencies, explaining how to use coal efficiently, and this is true. The main difficulty is that these pamphlets, though very good for the men with a fairly good education, contain a little too much for most boiler house foremen; written as they are, to cover in general all kinds of conditions throughout the country. I would favor using such publications as a basis, taking from them what seems to be specially adapted to the conditions existing. For instance, some recommendations regarding the proper care of boilers and use of fuel, are suited to all boiler plants. These, however, must be supplemented by a number of others which are adapted only to the boiler plant in which the book is to be used. It may be a question as to whether or not the safety rules for the operation of boilers should be included. My own opinion is that if these rules do not reach the hands of the boiler house foreman through other channels, they should by all means be included in such a book as we are discussing. Also, I think there should be a part which explains clearly and in simple language the different instruments which are used in the particular boiler plant, and how they are to be used so as to be an aid in efficient operation .

For aid in the preparation of such an instruction book as this, there is splendid and helpful information to be found in a number of existing publications.

There are also a number of good trade publications along the same line, prepared by companies manufacturing equipment used in improving efficiency in the operation of boilers.

In conclusion, I will add only this: Discussions by national and local engineering societies, of the fuel economy problem, are all right and necessary to stimulate interest and improve practice, but the interest should not stop with this. In the last analysis, fuel economy, with any given equipment, is effected largely by the men in the boiler plant. General engineering supervision alone is of itself insufficient. The men must be properly taught the details of their work as a fundamental basis of safety and efficiency. I hope that the means suggested herein as aids in their training will be a helpful contribution to a phase of this subject.

NEWS OF THE PLANTS

The Weirton Steel Company, Weirton, W. Va., has inagurated work on the proposed addition to its local plant for considerable increased capacity. The work will comprise a new open hearth steel plant, three new blast furnaces, and a number of new finishing mills. The open hearth plant will consist of an initial unit of seven 100-ton open hearth furnaces, with daily output of about 1,500 tons of steel. The John Walsh Company, Weirton, has the contract for the foundation work, and contract for the steel work has been let to the McClintic-Marshall Construction Company, Pittsburgh, Pa. A contract for some of the equipment to be used in the new plant has been awarded, and in this connection the Morgan Construction Company, Worcester, Mass., will furnish an 18-inch mill and 20-inch mill to be used for the rolling of slabs, sheet bars and small billets; orders will soon be placed for a 40-inch blooming mill. The new plant is estimated to cost in excess of $3,000,000, and will be rushed to completion. The work will also include a housing development of about 400 dwellings for employes, with hospital, as well as electric lighting plant, water supply system, sewer system, etc. The company recently completed the construction of a new blast furnace with output of 600 tons per day. The Weirton Steel Company has a capital of $30,000,000, and in addition to its local plant at Weirton, it has tin plate mills at Clarksburg, W. Va., and Steubenville, O.

The St. Louis Pressed Steel Company, 122 North Fourth street, St. Louis, Mo., is taking bids for the construction of a new plant at East St. Louis, Ill., to increase largely its present production. The initial structure will be one-story, brick and steel, about 100 x 200 feet, and is estimated to cost about $60,000. R. B. Button is president.

The Superior Sheet Steel Company, Canton, O., recently incorporated with a capital of $2,000,000, will soon inaugurate construction work on its proposed new plant. The works will be erected on the unit system, with initial unit to be equipped for a capacity of about 50,000 tons of material a year. A local site has been selected for the plant. Henry A. Roemer, formerly connected with the Canton Sheet Steel Company, heads the company.

The Kansas City Bolt & Nut Co., Kansas City, Mo., has arranged for the immediate construction of a large addition to its plant to cost in excess of $1,000,000, including machinery and equipment. It is planned to build five new open hearth steel furnaces, each with 50 tons daily capacity; three of these mills are expected to be ready for operation in the spring, giving the company an increased monthly capacity of about 65,000 tons. Adjacent to the new blast furnaces, a 22-inch rolling mill will be constructed, with traveling tilting tables and overhead traveling cranes, electric-operated. The furnaces will be arranged to use oil as fuel, and it is estimated that the consumption will be about 6,000,000 barrels a year. A battery of new gas producers will be installed, utilizing coal gas from the nearby fields. The majority of machinery and equipment will be electric-operated. Solomon Stoddard is general manager.

The Ohio Steel Products Company, Mineral Ridge, O., has completed plans for the erection of a new tube mill and conduit plant at Niles, O. Contract for erection has been awarded to the Crowell-Lundorff-Little Company, Merion Building, Cleveland. The works will comprise three one-story buildings, 60 x 400 feet, 85 x 160 feet, and 70 x 200 feet, and with machinery and equipment are estimated to cost about $200,000.

In connection with the proposed new automobile manufacturing plant of the Willys Corporation, 52 Vanderbilt avenue, New York, at Elizabeth, N. J., a number of buildings will be erected for steel and metal-working operations. The plant of the company at this location comprises the former works of the Duesenberg Motors Corporation, and a large tract of additional land has been secured for the proposed expansion. The new buildings will be of reinforced concrete and steel, comprising a one-story structure, 120 x 1,440 feet, and 320 x 400 feet, with a group of one- and two-story buildings on a plot 50 x 900 feet. Contract for building erection has been let to Warren Moore & Co., Colonial Building, Philadelphia, Pa. The new structures, with machinery and equipment, are estimated to cost in excess of $1,000,000. John N. Willys, head of the Willys-Overland Corporation, Toledo, O., heads the organization. A. R. Kelso is mechanical engineer.

The Carpenter Steel Company, Reading, Pa., manufacturer of billets, blooms, slabs, and kindred steel products, is continuing to increase the capacity of its plant. During recent months the company has made several additions, and has now filed plans for the construction of another large structure. The new steel mill will be of brick and steel construction, one-story, 147 x 280 feet, and with equipment installation, is estimated to cost about $120,000.

The Whittaker-Glessner Company, Wheeling, W. Va., is planning to increase the capacity of its plant by the installation of new steel furnaces. Preliminary plans are under way for a fireproof addition to cost about $100,000, including initial equipment.

The Follansbee Brothers Company, Pittsburgh, Pa., manufacturer of flat and corrugated steel sheets, tin plate, terne plate, etc., has perfected plans for the erection of a new steel works at Toronto, O., to be closely similar in size and capacity to its present plant at Follansbee, W. Va. The new plant will include a building 1,500 feet long for the open hearth steel works and hot mills; an annealing department, 100 x 700 feet; machine shop 50 x 200 feet; warehouse, 75 x 600 feet; steel scrap shed, 60 x 400 feet, and electric power plant, 60 x 100 feet. The present plant at Follansbee comprises four 3,500-ton open hearth furnaces, six tin plate mills, and seven steel sheet mills, with auxiliary operating structures, and has a capacity of about 65,000 tons of finished material yer year. The new plant at Toronto is estimated to cost about $2,000,000, and will include a housing development for employes consisting of an initial unit of 300 dwellings; this work will also comprise water supply system, sewer system, electric-lighting facilities, and other utilities. It is said that the new works will give employment to about 1,000 men for initial operations. William U. Follansbee is president. To provide in part for the new plant, the company has arranged a bond issue of $1,500,000.

The National Roll & Foundry Co., of Avonmore, Pa., has received the contract for the new sheet mill installation of the Follansbee Brothers Company, to be located at Toronto, O., and consisting of 10 roughing mills, 10 finishing mills, 10 stands of cold rolls, and the necessary equipment that goes with it, as well as a complete two-high reversing sheet bar mill, including all the tables and cooling bed. The National Roll & Foundry Co. is also building the hot mill equipment for the Easton Steel Company, at Baltimore.

The Hammond Steel Company, Inc., Milton avenue, Solvay, near Syracuse, N. Y., is planning for the construction of additions to its plant for increased capacity. The new structures will be 80 x 250 feet, and 40 x 60 feet, and will cost in excess of $200,000, including equipment. The company has arranged for a note issue of $600,000 for its proposed expansion. Contract has been let to the Electric Furnace Construction Company, Finance Building, Philadelphia, Pa., for one three-ton furnace, electrically-operated, to be used for the manufacture of high grade tool steel. F. B. Scott is president.

INDUSTRIAL RELATIONS

SAFETY AND AMERICANIZATION IN INDUSTRY.

In the executive series sent out by the National Safety Council for the information of the management of industries, on industrial relations problems, the council gives some simple and plain rules for industrial plants on Americanization work and the close association of this problem with the welfare, employment, and safety departments of an industrial concern. The 11 suggestions made by the council for making good Americans are given below:

Safety for New Americans.

1. Americanization work should be closely connected with the welfare, employment, and safety departments, and should coöperate with the local public school system.

2. A census should be taken of all foreign born employes and such data secured as country of birth, length of time in United States, age and sex, family here, ability to speak, read, or write English, desire to learn English, first or second naturalization papers and dates issued, intention to remain in United States, desire to become citizens. Such individual information is useful for permanent follow-up work.

3. If number of non-English speaking employes is small (less than 20), arrange with the public school, the Young Men's Christian Association, or similar agency to tell your men what you want them to learn. Check up and urge regularity of attendance.

4. If there are 20 or more and you find after investigation that the agencies mentioned above cannot adequately handle the instruction, then secure a teacher and a suitable classroom and handle the work as part of the plant operation.

5. Classrooms should be conveniently located, well lighted and ventilated, and equipped with furniture suited to the needs of adult students.

6. The teacher should possess a thorough general education, some preparation in the technique of teaching, sufficient health and vigor to make the teaching forceful, and appreciation of the social problems of the community, and a personality which will encourage response on the part of the class.

7. The scope of the course for new Americans should take into consideration three elements of schooling:

(a) Ability to understand and speak simple English.
    (1) Vocabulary of the industry.
    (2) Vocabulary of the home and street.
(b) Ability to read simple English, including experience in reading.
    (1) Elementary material on safety, hygiene, and government.
(c) Ability to write signature and home address in English, and, where possible, sufficient training to write a simple letter.

8. If attendance at English classes is made compulsory, employes should be paid at the regular rate for time spent in classroom.

9. An important part of Americanization work is to teach your employes about our government and the advantages of citizenship. Classes in citizenship should be started at the earliest opportunity. Attendance at these classes should be voluntary and employes should receive no pay for attendance. The principles of democracy upon which our government is founded preclude the forcing of men to become naturalized citizens. The only way to make an American citizen is to put the individual in an environment which will make him appreciate the responsibilities and advantages of popular government. Prevent anti-American propaganda in your plant by providing information and coöperation on true Americanism.

10. Gain the confidence of your employes by establishing an office in the plant where alien workmen can come at regular hours to receive reliable information, advice, and assistance, thereby preventing their falling into the hands of unscrupulous legal advisers and other dangerous persons.

11. The safety department should be an important factor in Americanization work. Lessons on safe practices should be given and the employe eventually be made to feel that safety regulations can best be enforced by himself—an important step in the teaching that the interests of the industry are after all the interests of the employe.

FIFTY AGENCIES TO HELP.

Cleveland Americanization Council has before it the coördination and direction of the Americanization work of 50 agencies interested in this work. They believe that by the coördination of these activities Cleveland can become one of the most American cities in the United States.

The council now has under way a survey of the chief factories. Questionnaires have been sent out asking the number of foreign-born persons employed in each shop.

RACIAL BACKGROUNDS GIVEN IN MAGAZINE.

During the past year the *Literary Digest* has offered to its readers studies of the racial backgrounds of 30 immigrant races which have settled within the borders of the United States. Such clear, concise statements are invaluable to Americanization workers who have not much time in which to make a study of the race with whom their work brings them in contact.

The articles are still being published, but a table of the races and the dates of publication of issues containing the articles as given previous to July 1 was given in September 20 issue. We are copying:

Americans of Austrian birth	Sept. 28, 1918
Columbus Day	Oct. 12, 1918
Greeks in America	Dec. 7, 1918
Armenians in the United States	Jan. 4, 1919
Czecho-Slovak Republic	Jan. 11, 1919
Swedes in the United States	Jan. 25, 1919
Jugo-Slavia	Feb. 1, 1919
Norwegians in the United States	Feb. 8, 1919
Poland	Feb. 15, 1919
Danes in the United States	Feb. 22, 1919
Lithuania	Mar. 1, 1919
Poles in the United States	Mar. 8, 1919
Greece	Mar. 15, 1919
Spaniards in the United States	Mar. 22, 1919
Armenia	Mar. 29, 1919
Bohemians in the United States	Apr. 5, 1919
Roumania at the peace table	Apr. 12, 1919
Lithuanians in the United States	Apr. 19, 1919
Syrians in the United States	May 3, 1919
Ukraine	May 10, 1919
Finns in the United States	May 24, 1919
Lettonia	May 31, 1919
Jugo-Slavs in the United States	June 7, 1919
Esthonia	June 14, 1919
Letts in the United States	June 21, 1919
Finland	June 28, 1919

PRODUCTION TOPICS

REPORT ON EXPERIMENTAL USE OF POWDERED FUEL FOR PUDDLING FURNACES.

By W. Simons, Stoke-on-Trent.

Before deciding to incur the large expenditure involved in adopting a powdered-fuel plant for the forge, it was arranged, in view of the many factors that enter into the question, to make an experiment at one of the puddling furnaces of the Shelton Iron, Steel & Coal Co., Ltd., and a plant was ordered in this country (England) for the purpose, the powdered fuel for the test being specially obtained from a crushing plant usually used for cement.

The fineness of the coal dust was all that could be desired, but owing to the dust having to be brought a considerable distance on the railway, a quantity of moisture was absorbed, and the powdered fuel therefore contained more than is desirable and more than would be obtained if a complete plant were put down at the forge. The moisture in the fuel used for the experiment varied from 1½ to 2½ per cent, but there would be no difficulty in getting it down to 1 per cent.

Heating up—No difficulty was experienced in getting the requisite temperature. The time taken for heating the furnace from cold did not take more than 1½ hours, as compared with three to four hours required for ordinary firing.

Wear in Brickwork—With the first position in which the burner was fixed the flame caught the roof of the combustion chamber, causing rapid wear of the brickwork. The position of the burner was altered, and at present comparatively little wear is taking place, but there is no doubt that further improvements can be made in the combustion chamber and in the form of the furnace to adapt it to this system.

Fuel Consumption—This works out at about 30 per cent better than the usual consumption of fuel per ton of iron made. Further economies can be made with the experimental plant, and with the greater range of regulation that would be provided in a complete plant still further reductions in fuel consumption could undoubtedly be effected.

Waste Heat—A meter was fixed to the feed-water pipe of the boiler and the evaporation of the boiler was reduced by 10 per cent for 30 per cent reduction in fuel, but with the increased output that could be obtained by the use of powdered fuel there should be no reduction in the total evaporation of the boiler previously obtained.

Output—There is no doubt that greater output can be obtained with powdered fuel owing to the complete combustion of the fuel. The under hand is relieved of the work of firing and is set free to assist the first hand. Heats were worked in 1½ hours, and in one case one hour and 20 minutes, and the furnace was held back to some extent by having to take its turn with other coal-fired furnaces.

General—The result of the experiment leaves no doubt that there is a great advantage in using powdered fuel for firing puddling furnaces. Greater output can be obtained, and economy of at least 30 per cent should be obtained in the fuel used.

The men who have worked the furnace appear to be pleased with the result, and are anxious to know whether it is intended to put down a complete plant.

On the basis of 30 per cent fuel economy, and taking the cost of a plant for about 10 puddling frnaces and firing two Lancashire boilers (which are adjacent to the forge) as being £22,000, and allowing 2s 9d per ton on fuel for grinding, but without allowing for interest and depreciation, there is a net saving per annum of 23 per cent on the capital outlay.

In view of the importance of fuel economy, the result of this experiment may prove of interest.

Paper read before British Iron and Steel Institute.

A NEW DEVELOPMENT IN HOISTING MACHINERY.

By Warren Travell.

So much attention has been given during recent years to the design of hoisting machinery and the various types have been so highly perfected that an improvement in such apparatus embodying a new principle of operation is most unusual and calls for special notice.

Such an improvement in hoisting equipment has recently been developed by the writer and put on the market by N. B. Payne & Co, New York. In this apparatus, which is applicable to all installations where vertical hoisting and horizontal traversing of loads is required a single drum is used for these two movements in place of the customary two drums. The shift between vertical and horizontal motion is accomplished by means of a lever which controls a pair of rope grips.

Another important feature of this apparatus is that during the hoisting operation, the entire dead load of the skip or bucket and half the live load is balanced by a counterweight which reduces the size of hoist and motor and also effects a large saving in the amount of power required as compared with other types of apparatus in which no counterweight is used.

During the operation of lowering, the motor is working to raise the counterweight, thus obtaining a control somewhat similar in effect to the well known dynamic braking and much safer in operation than the common method of lowering with a brake. As the hoist drum is rigidly keyed to its shaft, no friction clutch is required and freedom is obtained from the troubles incident to this device.

This new type of balanced hoist and transfer is adaptable for use on hoisting towers, cargo cranes, traveling bridges, cableways and, in general, on all hoisting apparatus in which there is a free hoist and horizontal movement of the load. For grab-bucket work, there is required for the holding line, an additional drum, which may be of the counterweight type, without connection to the motor. The advantages of this improved hoist may be briefly expressed by the statement that it uses one drum less and about half the power of the more common types of apparatus doing similar work.

In connection with this balanced hoist, another interesting improvement consists of an extensible boom, which is especially suited for use on cranes loading and unloading vessels. The boom may be extended or withdrawn in the direction of its own length and gives minimum interference with the stays, lines and wireless aerials of a vessel. An important feature in the design is the means adopted for paying out at a predetermined varying rate of the ropes supporting the outer end of the boom. When used in combination with the balanced hoist equipment, the hoisting apparatus is operative at all points of extension of the boom as the slack rope resulting from the drawing in of the boom is taken up by the counterweight. This enables the crane to handle freight on the pier, while vessels are being moved alongside

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The American Machine & Foundry Co., Second avenue and Fifty-sixth Street, Brooklyn, has awarded a contract to the H. D. Best Company, 949 Broadway, New York, for a five-story plant addition, 100x192 feet, with extension, 30x40 feet, to cost about $300,000 with equipment.

Construction has been started on the new plant of the Detroit Seamless Steel Tubes Company, Detroit, and it is expected to have the first unit ready for occupancy about January 1. There will be three manufacturing units, each 90x500 feet, in addition to an administration building and heat treating plant.

FOREIGN RELATIONS

COAL PROBLEM EUROPE'S GREATEST MENACE.

"The greatest menace to the stability and life of Europe" is what Herbert Hoover calls Europe's coal situation in a report to the Supreme Economic Council of the Peace Commission, published for the first time in *The Street,* the illustrated financial weekly. Mr. Hoover shows that the production of coal in the principal countries of Europe has fallen from 679,500,000 tons in 1913 to a rate of only 498,600,000 tons this year, a decrease of 27 per cent. As the consumption of coal by certain vital consumers such as transportation, municipal and other essential services cannot be decreased in this ratio, the report points out that the shortage of coal manufacture and household use must be on a far greater scale. Europe did not accumulate its customary reserve of coal during the past summer, according to Mr. Hoover's observations, and it is pointed out that this will further increase this winter's hardships, while the tendency of producing countries to reserve to themselves a larger degree of their normal consumption will cause a still further under-supply for the non-producing countries.

Among the many causes of this shortage of coal which the report enumerates, Mr. Hoover places first the repeated strikes and industrial unrest. His remedies are increased production and organization of distribution. In this connection Mr. Hoover makes the significant remark that "it would perhaps contribute to the first problem if the coal miners and coal owners of all Europe could be brought to a realization that the fate of European civilization now rests in their hands to a degree equal to, if not greater than, in the hands of the providers of food supplies during the next year."

Mr. Hoover's report is supplemented by tables of coal production and consumption and by detailed descriptions of conditions found in the coal mines of Poland and Czecho-Slovakia by the American officers of the Inter-Allied Coal Commission.

EUROPEAN CREDIT GIVEN ATTENTION.

Organization of the national committee on European finance, to study definite plans for supplying the necessary long time credit for Europe's purchases in the United States, was announced November 24. This committee is appointed by the Chamber of Commerce of the United States following the recommendation of the committee on credit and finance of the recent International Trade Conference at Atlantic City. At that conference representatives of American business, industry and banking conferred with unofficial representatives from England, France, Belgium and Italy on the commodity and credit needs of their respective countries.

Organization of this committee is believed to be a step toward the solution of the most important peace-time financial problems which have ever confronted a nation. The task before the committee is to devise ways and means for speeding up a return to normal in the trade relationships between the United States and Europe. Leading business men believe that only by the full coöperation of the investing public and all the commercial, industrial and financial interests throughout the entire United States can this task be performed.

The chairman of the new body is Harry A. Wheeler, vice president of the Union Trust Company of Chicago; Mr. Wheeler was the first president of the Chamber of Commerce of the United States. The chairman of the executive committee is James S. Alexander, president of the National Bank of Commerce in New York. The membership has been drawn from among men of experience in all the various lines of business activity and important affairs of the nation and is representative of all sections of the country.

OFFICIAL INTERPRETATION OF FRENCH EIGHT-HOUR LAW.

A great deal of comment has occurred in France over the provisions of the eight-hour law passed by the French National Assembly April 23, 1919, and the following summary of a circular issued over the signature of M. Colliard, minister of labor and social welfare, a translation of which has been forwarded from Paris by Ambassador Hugh Campbell Wallace, will be of interest as giving the official interpretation of the application of the law.

The law itself was very general, leaving administrative regulations to be worked out later, it even being left to these regulations to fix the dates when the law should become effective in a given trade, industry, or political subdivision. Employers' and labor organizations have, in the meantime, been making voluntary agreements as to the application of the law to themselves, and legislators have been more inclined to await these agreements and accept them, at least as the basis for administrative regulations, than to promulgate regulations without consulting the parties most concerned. Such voluntary agreements are, however, of no legal force if they contravene the spirit of the law, and are subject to modification by subsequent official rulings.

While the law makes no express provision for uniformity of regulations, it is the sense of those interested in its application that an effort shall be made to avoid a diversity of systems within the same industry and to bring about national agreements which shall fix the principles destined to serve as a frame for regional or local regulations.

Scope of the Law—Elasticity of Its Application.

The law is to be applied, in general, to all workmen and employes of commercial and industrial establishments and enterprises, including mining enterprises (which were not specifically mentioned in the law), and to all classes of public employes, but is not applicable to agricultural laborers.

The duration of work fixed by the law is understood to be the duration of work, and does not include rest periods. The law limits the daily hours of work to 8 and the weekly hours to 48, but provides for "any other equivalent limitation." It is understood that in some forms of work, e.g., of railroad labor, the 8-hour day is not practicable, but no "limitation" can be considered within the meaning of the law if the average day's work is more than 8 hours.

The maximum of working hours may be fixed either by day or by week. If it is fixed by the week, a regulation must be made distributing the 48 hours over the various days of the week. In this way, for example, Saturday half holidays may be provided.

It is lawful for employes and workmen to agree on a maximum number of hours which is less than that prescribed in the law. The law shall be considered as contravened only when the maximum is greater than 48 hours per week.

Public regulations may confine themselves to fixing the number of effective working hours for each day; but they may likewise apportion those working hours throughout the day, providing for and fixing the times of rest periods; and they may fix the time of beginning or of ending work.

Derogations Permitted in Certain Instances—Wages.

The law provides for two kinds of derogations, permanent and temporary. Permanent derogations allow the maximum hours to be exceeded in a permanent manner and may be applied in instances in which the nature of the work is such that it must be performed outside the regular fixed hours, or when the labor performed is essentially intermittent in character. Examples of the latter sort comprise gatekeepers, railroad station agents on lines little frequented, etc.

Some Pointers on By-Product Coke Oven Operations

COKE OVEN GAS REHEATER IMPROVEMENT.

(Continued from page 606)

finely subdivided bodies. This refinement would not be essential if the reheater is considered strictly as a heating apparatus. However, the reheater may be so constructed as to be an emergency tar precipitator for bringing out of suspension with the gas any such tar mist that may have escaped precipitation within the tar extractor. This can be arranged without increasing in the least the heating surface required for any given size reheater.

No matter how efficient the various apparatus for removal of tar may be there is always found on the inside surface of all gas mains right up to the saturator itself, which includes the reheater, deposits of tar which constantly precipitate and flow out of the drains and traps provided for such condensation, and when there is a failure of the cooler and tar extractor to function properly, more or less tar will always pass through the reheater and on into the saturator with the gas. On the inside surfaces of the saturator this tar collects in gobs and also mixes with the ammonium sulphate salts which it discolors or flecks with tar specks, thus damaging its market value as fertilizer, for which it is mainly used.

It is within the reheater therefore that the last attempt at tar precipitation may be attempted by refinement of the design, and the application of the common principle and construction applied to all other apparatus heretofore described.

This may be accomplished by providing radiator plates in the reheater identical to the cooler plates described in the article on the primary cooler in the October issue. Instead of water circulating in the compartment as is the case when used as a cooler plate, steam is directed into the compartment through the steam inlet and the condensed steam in form of water is drained off through the steam outlet which inlet and outlet correspond to the water inlet and outlet of the cooler plates.

The radiator plates are arranged within a square cast iron or steel shell about as shown in Fig. 1. The plates may be as small as ½ inch inside the compartment and the surfaces may be indented to a depth that will accomplish the spacing the plates ¼ inch apart which permits the gas in films of ¼ inch in thickness to pass between the plates. The gas absorbs heat radiated through the thin walls of the radiator plates, and in coming into intimate contact with the corrugated surfaces of the radiator plates precipitates any tar that may still remain in the gas upon them.

No more heating areas; or slightly less is necessary when using the radiator plates, than is used in the tubular construction of reheater, the radiator plate surfaces being more effective in heat radiation than the tubular surfaces.

The steam inlet and outlet of each plate are connected to the hollow door frame through which the steam is admitted and the condensed steam carried off. A cover bolted to the frame seals the apparatus.

The gas may enter either at the top or bottom connection for the gas main. The steam may enter at the topmost steam connection and piping may connect up the door frame steam inlet and outlet connections either in series or in multiple.

The size of a reheater of the usual tubular construction of 5,000 square feet of heating surface with 3-inch tubes requires a height of tubular space of 20 feet with a diameter of 6 feet, while the radiator plate construction would require a height of 10 feet in a space of 5 feet square and the heating surface provided would be more effective in the removal of unextracted tar from the gas as it passes through the reheater, each cubic foot of gas being subjected to intimate contact with 225 square feet of impinging surface in films ¼ inch thick.

It is evident that if the cooler and radiator plate construction described in this and the October issue is applicable to apparatus for cooling and heating gas, the same construction is also applicable to all types of apparatus for cooling, heating, condensing and heat exchanging, met with in power plant, chemical plant and oil distillation equipment wherever tubular apparatus is at present used especially where the operating pressures are not high.

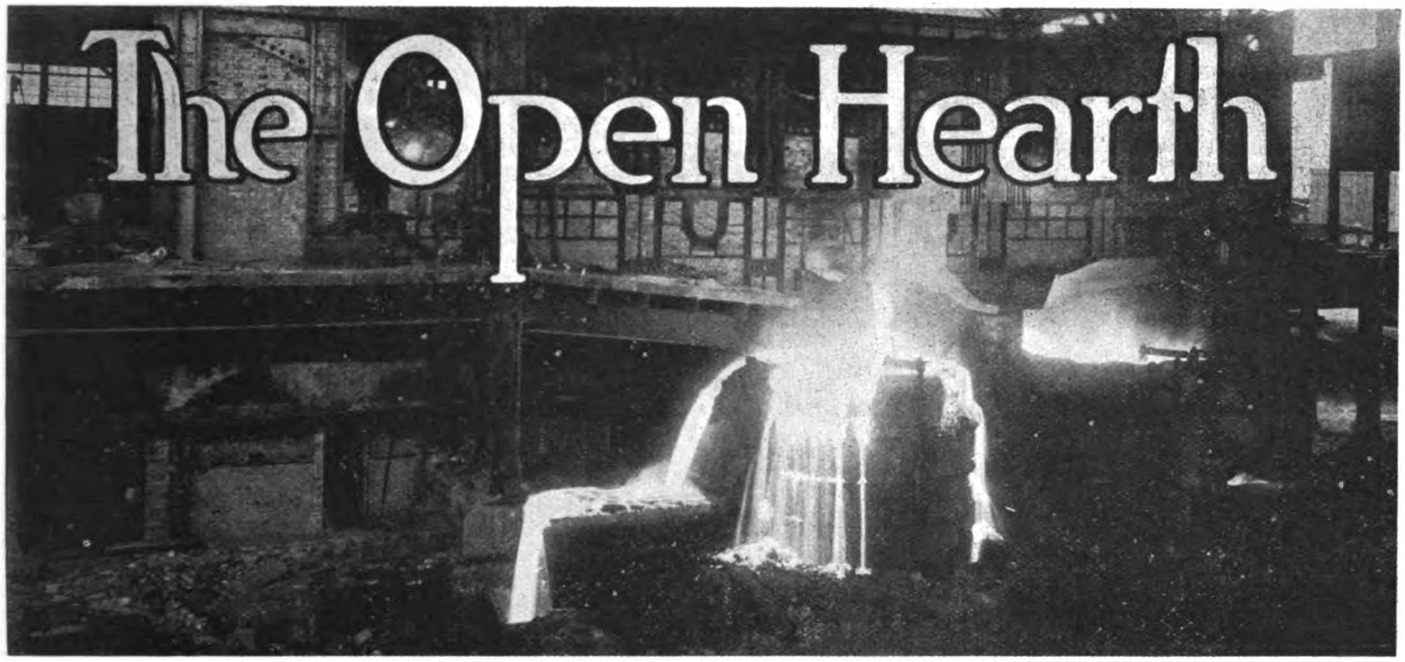
There are numerous applications of this construction possible to many types of byproduct apparatus, namely the condenser and dephlegmator for aqua ammonia vapor condensation, and the preheater, or heat exchanger used in both the ammonia and benzol recovery operations. It is particularly adapted to fractionating condensers, such as are used in the recovery of the various constituents of crude benzol, or of crude petroleum by accomplishing the progressive condensation of the vapors of benzol or petroleum after their distillation, and permitting the condensates to be drawn from the condenser at the points of condensation of the various constituents, it being possible to provide for increasing or decreasing the condensing area at will.

Probably the broadest application of the cooler plate construction is to that of feed water heaters and steam condensers, especially where limited space requires apparatus of great compactness as in old power houses of limited size where large installations are to be made and in the engine and boiler rooms of merchant and warships where it is possible to provide more than twice the condensing area in a given space with the cooler plate construction than is possible in a tubular type of condenser using two inch tubes. Fig. 2 shows a horizontal surface condenser of cooler plate type, the cooler plates removable at either, or both ends, thus saving half the end room required for insertion of new tubes in a tubular condenser.

In this type of condenser the cooling water enters at the bottom of the cooler plates, thus condensation of the steam is progressive and equalized throughout the entire condensing area of the apparatus and by provision of slightly more than the requisite surface for condensation of steam alone it is possible to provide by this construction a combination condenser and feed water heater, providing of course, that the cooling water used for condensation is fit for use as boiler feed water, which is possible in plants where either feed water purifiers or water distillation apparatus is provided along with water cooling equipment. The cooling water in passing through the cooler plate from bottom inlet to top outlet progressively absorbs heat and leaves the cooler-plate at the point where the exhaust steam is the hottest, thus permitting the greatest possible amount of heat absorption by the water which at this temperature may be used as boiler feed water without the necessity of passing it through special feed water heating apparatus thus saving the expenditure and space required for such apparatus.

The Traylor Engineering & Manufacturing Company, Allentown, Pa., manufacturer of crushing, metallurgical, coal-briquetting and other machinery, will establish a plant for the manufacture of automobile trucks and tractors at its former shipyard at Cornwells, Pa. The works will be remodeled and reequipped to produce trucks of 1, 1½, 2½ and 3 tons' capacity, to be ready for operation about January 1.

The Belleville Wire Cloth Company, 705 Washington avenue, Belleville, N. J., is gradually increasing its manufacturing facilities by the addition of wire-working looms.



The Open Hearth

REORGANIZATION AND EXPANSION OF THE READING IRON COMPANY.

W. Woodward Williams.

Edgar F. Blessing.

The Reading Iron Company, of Reading, Pa., the largest manufacturer of wrought iron pipe, is undergoing reorganization under the direction of L. E. Thomas, the newly-elected president.

Mr. Thomas, who succeeded F. C. Smink, was formerly vice president and general manager of the Birdsboro Steel Foundry & Machine Co. Mr. Thomas has had a broad and varied experience in the iron and steel business, having held several important operating positions in the Ohio works of the Carnegie Steel Company, and later, while identified with the United ngineering & Foundry Co., installed some of their best equipment in the leading steel plants of this country. For 14 years as vice president and general manager of the Birdsboro Steel Foundry & Machine Co., he was largely responsible for building up this concern, until to-day it is one of the most successful in its particular line of business. He has already been singularly successful in keeping the Reading Iron Company from labor troubles which have been so prevalent throughout the iron and steel industry, and under his able management, all previous production records have been broken.

Leon E. Thomas.

W. Woodward Williams, General manager of the company, was for several years general manager of the A. M. Byers Company, of Pittsburgh. In that position and as general sales manager, he formulated the progressive sales and advertising policy which was signally effective in stimulating and extending the market for iron pipe. Mr. Williams succeeds Mr. George

Craig Geddis.

W. E. Dunham.

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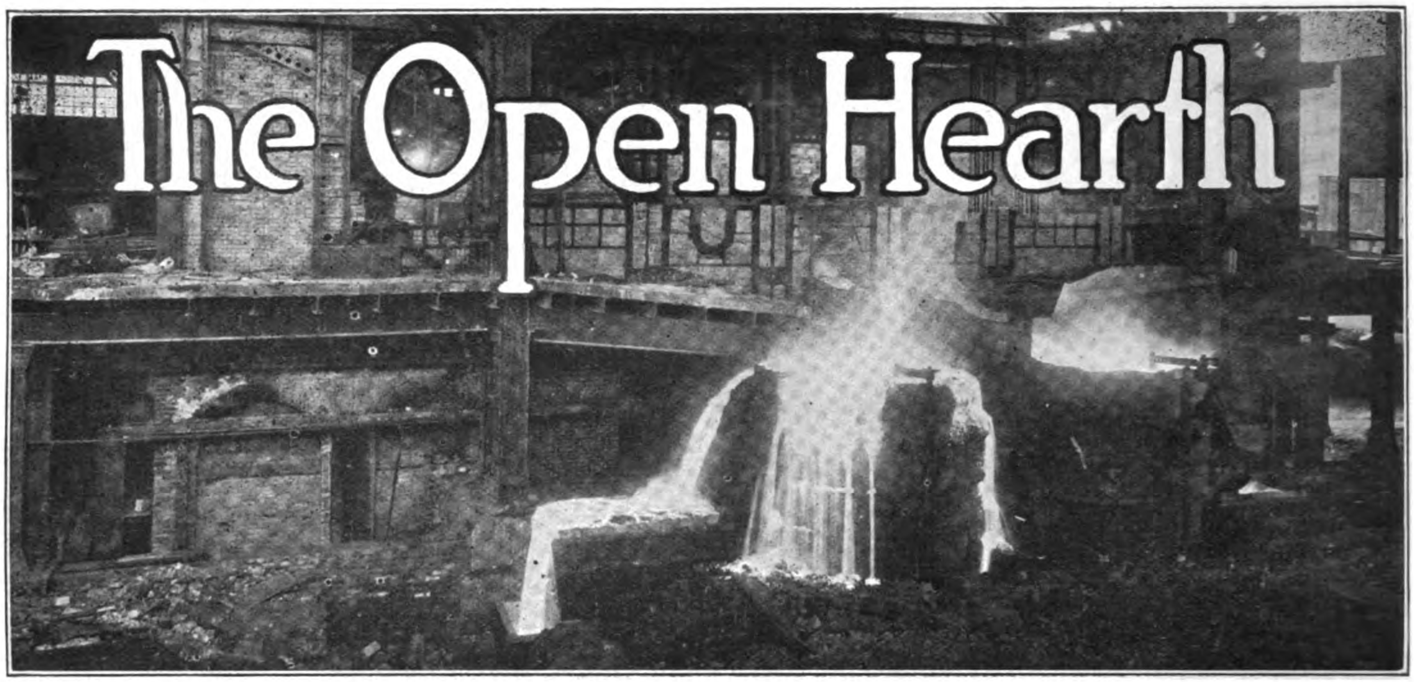
The Open Hearth



Schuchmann, who retired on August 1, 1919, because of ill health.

Craig Geddis, advertising manager, formerly connected with the sales and publicity departments of the National Tube Company, and later publicity manager for the Mesta Machine Company, brings to the new organization a broad experience in both sales and publicity work.

Important additions to the production departments of the organization include the appointment of Edgar F. Blessing as metallurgical engineer, and W. E. Dunham, as production engineer. Mr. Blessing was formerly connected with the Doehler Die Casting Company, Brooklyn, N. Y., and Mr. Dunham was, until very recently, service manager for the A. M. Byers Company.

Among the many new developments which have followed the reorganization of the Reading Iron Company, is the purchase of the George B. Lessig Company plant, at Pottstown, Pa. By the acquisition of the Lessig plant the Reading Iron Company secures an additional monthly muck bar capacity of 2,600 tons, and, incidentally, becomes the largest manufacturer of cut nails in the United States. The Lessig nail factory has been renovated and the equipment improved throughout. It was put in operation November 6.

The Reading Iron Company has also purchased from the Empire Steel & Iron Co., 10 acres of land adjoining their tube works, for use in future extensions.

Important changes have been made in the sales policies of the company. Branch offices for the district sales representatives have been established at Philadelphia, Pa., New York, N. Y., Pittsburgh, Pa., Chicago, Ill., Dallas, Tex, and Cincinnati, O. Additional branches now being located will be opened by the company in the future.

The Reading Iron Company is twice as large as any other wrought iron pipe manufacturer. Entirely self-contained from the blast furnaces to the shipping platform, its equipment is of the most modern type throughout. Five hundred and fifty-two different sizes and kinds of tubular products, ranging in size from ⅛ inch to 20 inches, are being regularly produced.

The pipe and tube mills of the Reading Iron Company are equipped with five lap weld furnaces, three butt weld furnaces, together with the necessary auxiliary departments—socket shop, galvanizing department, tar dipping department, jobbing department, nipple department, etc. The skelp for the lap weld pipe mills is furnished by two Universal mills also located in Reading. These mills manufacture skelp down to 9⅝ inches in width. For the manufacture of skelp in smaller sizes the Reading Iron Company operates six grooved skelp mills in or near the city of Reading.

Muck bar made of all pig iron is supplied to the skelp mills by six puddling plants located in and about Reading, in which the principal equipment alone consists of 112 double puddling furnaces.

With the present muck bar and skelp capacity, the pipe mills of the Reading Iron Company are capable of producing 200,000 tons a year and are at present operating well above this rate of production.

In addition the company owns and operates the Scott foundry, Reading, in which are produced all classes of machinery, especially sugar mills; also a forge shop, chief product of which is heavy marine forgings. The company also owns and operates 7,574 acres of coal lands in Somerset county, which is known as the Somerset coal department.

V V

Comly B. Shoemaker, Jr, has been appointed assistant superintendent of the Roe puddling department of the Reading Iron Company.

V V

Westinghouse, Church, Kerr & Co., Inc., announces the appointment of Russell W. Stovel, recently Lieut-Col., Engineers, United States Army, as a consulting engineer. Mr. Stovel has had an unusually comprehensive experience in the mechanical and electrical problems connected with central power station and steam railroad electrification work, as well as a valuable experience in the mechanical handling of freight at water terminals. Mr. Stovel had direct charge of the Paoli and Chestnut Hill electrifications of the Pennsylvania Railroad and the Elkhorn grade electrification of the Norfolk & Western Railroad. With the American Expeditionary Forces in France, Lieut.-Col. Stovel served as chief of the terminal facilities division of the army transport service, one of the two big divisions of transportation of which Brig.-Gen. Atterbury was the chief.

V V

George S. Vail, sales manager for Arthur G. McKee & Co., of Cleveland, O., sailed from New York on the steamship Adriatic, November 29, for England, where he will spend several months on business for his company in connection with the installation of modern blast furnace and steel plant equipment.

Mr. Vail was accompanied by George Garrett, who will establish an office and remain in England permanently as the English representative of Arthur G. McKee & Co.

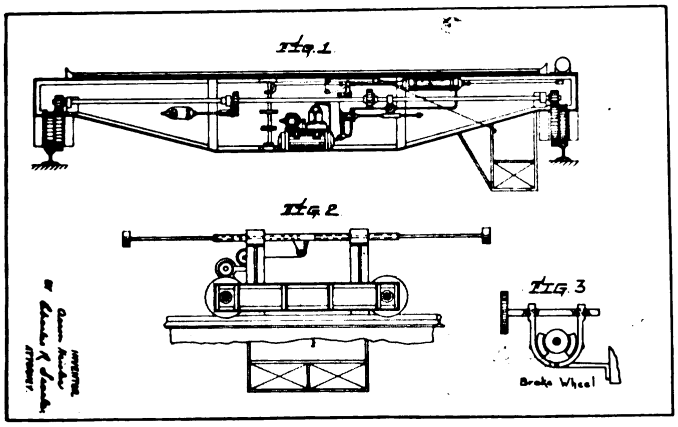
V V

Charles B. Carter has been appointed sales manager of the Chicago Steel Foundry, Chicago, Ill.

WITH THE EQUIPMENT MANUFACTURERS

SAFETY DEVICE FOR TRAVELING CRANES.

The accompanying description will give the reader an idea of a safety device designed and patented by A. Heisler. In Fig. 1 of the illustration, a side view of a crane is shown with the device mounted thereon. In Fig. 2, end view of crane is also shown with both bumpers mounted in their normal position, but one bumper may be mounted on opposite ends of girders and same results will be obtained. One end of a cable is fastened on the bumper and is led over suitably placed wheels; the other end of cable being fastened to one end of a piston rod in an air cushioning chamber and a second cable is fastened on the other end of said piston rod, leading over suitably placed wheels to a series of pickup weights which are fastened to the end of the second cable. On the second cable is fastened a button or stop which engages a pronged lever of a two-part bell crank lever. The horizontal part of this bell crank has a connecting means to an air valve so when the bumper is forced rearwardly the button or stop engages the pronged lever letting air into an airbrake cylinder. The piston rod of this airbrake cylinder has a toothed rack on one end engaging a gear wheel on a shaft having a right and left thread thereon, said right and left threads engaging similar threaded members in the brake frame. The air entering the airbrake cylinder at one end causes the gear rack and wheel to fasten or grip the brake wheel on the main shaft by means of the right and left thread members. A means will also be provided whereby the operator may apply or release the brake at will. A means will be provided for the operator to remove the vertical lever of the bell crank out of the way of the stop on second cable so that two or more cranes may operate close together as a unit, if desired without applying the brake. The function of the air cushioning cylinder is to partially keep (or wholly if desired) the bumpers in a forwardly position and also prevent too sudden jerk or jar or damage to the series of pickup weights in case the bumper is very swiftly operated. The series of pickup weights is destined to be the principal means to give resistance to the slidable bumper and the air cushioning cylinder an auxiliary means. The object of having a right and left threaded member to operate the brake is that if air leakage occurs, the brake will still hold until released but if a straight line pull was used and air leakage occurred, the brake would not hold and this is not desirable because gantry cranes or ore bridges could not be securely fastened and any such cranes might be damaged during heavy winds. A means will provide for air to enter one end of the cushioning cylinder regulated to suit conditions from the air pressure tank. A motor and compressor will be used to give suitable air pressure to the pressure tank.



View showing safety device.

It might be noted that this device is especially adaptable to foundry cranes as cranes so equipped cannot bump into each other should one of them be pouring hot metal at time of meeting as the bumpers will cause the oncoming crane to slow and stop before damage is done. Then too the means for controlling the brake will be as easy as operating a lever of a controller. Also a hose may be conveniently attached to the air pressure tank or any other convenient place and the operator may have a good means for keeping the carriage, cab, controllers and bridge motor clean. Heretofore large springs and timbers have been used to prevent collision but such timbers could not give much relief from heavy shock and the springs were but a little better.

This device may be applied to any crane or may be incorporated at the time of building the girders. A crane is quite a costly item and should be provided with safety devices as well as other machinery. Then too a crane equipped with this device is ahead of any safety law that might be designed to give protection for such mechanism. This device is automatically applied, manually released or applied, easy and quick to effect release or application, and if required a little more speed on the track may be had with greater security because of such a device. Also a crane remaining stationary for repairs is secure from collision by another crane or cranes.

A few small minor parts of no great consequence or importance will be added to make this device easier to operate.

INGERSOLL-RAND PORTABLE AIR COMPRESSOR.

The Ingersoll-Rand Company, 11 Broadway, New York City, has recently introduced a portable, lightweight gasoline engine driven unit, built in two sizes, to be known as the Imperial Type 14 portable air compressor. These are all-steel outfits, from their sheet-steel canopy to the broad-tired steel wheels. The power plant of each consists of a duplex vertical compressor, driven at high speed by a four-cylinder four-cycle tractor type of gasoline motor. It is pointed out that the outfit, being designed especially for portable use, has had unnecessary weight eliminated, and affords maximum air power output per unit of weight. The larger machine, of 210 cubic feet capacity weighs only 6,000 pounds and the 118-cubic foot unit weighs 4,000 pounds. A point is also made of the fact that gasoline motor drive provides power in an economical form and in a mechanism that can be confidently intrusted to the average operator, for men familiar with gasoline engines are everywhere available and make thoroughly competent engineers.

The Colonial Steel Company, Pittsburgh, Pa., has published a tool steel treating book, containing directions for the heat treatment of high speed steel and carbon tool steel. The book also includes lists of tools, and grades of Colonial steel best adapted for their use.

The Pullman Company, Chicago, manufacturer of railroad cars, is arranging for an extension of operations and is equipping one of its buildings for the manufacture of automobile bodies.

The Follansbee Bros. Co., Pittsburgh, which will build a new sheet mill at Toronto, O., has an inquiry out for about 25 cranes, ranging from 5 tons up to 50.

Trade Notes

The Booth Electric Furnace Company, whose incorporation was announced in these columns a few weeks ago, has opened up the following district offices in connection with the sale of electric furnaces for melting steel, iron, and non-ferrous metals. For New York and New England, Edward B. Scott & Co., Flatiron Building, New York City, with E. F. Tweedy, secretary of the company, directly in charge; for Eastern Pennsylvania, New Jersey, Maryland, and Southern Atlantic coast states, Northern Engineering Company, 308 Chestnut street, Philadelphia, with F. W. Doran in charge; for Northeastern Ohio, Western Pennsylvania, and Western New York state, Charles L. Foster, formerly sales manager of the Electric Furnace Company, of Alliance, O., with offices at 879 the Arcade, Cleveland, O. In connection with these district offices a complete staff of engineers and metallurgists will be maintained so that the needs of customers can be promptly met and adequately taken care of.

Hamilton & Hansell, Inc., 13 Park Row, New York City, from now on dedicate their entire business to metallurgical and general engineering work. In conjunction with domestic work, they will carry on development of foreign patents and enterprises. A separate company, namely, the American Transmarine Company, has taken over all the general export and import business not relating to engineering.

For the past five years Hamilton & Hansell, Inc., has been licensee and builders of the American Rennerfel Electric Furnace for ferrous and non-ferrous work, and have also designed a number of electric reduction and electrochemical plants. Work of this nature will be pushed more intensively than before. The following contracts were closed during the last three months: One 1,000 pound 200 kva Rennerfelt furnace, for special iron, A. M. Byers Company, Pittsburgh, Pa.; one 200 kva Rennerfelt special furnace, for glazing fused silica, General Ceramica Company, Perth Amboy, N. J.; one four gross ton, 1,200 kva Rennerfelt furnace for tool steel, for export to Sweden; one 300 pound 100 kva Rennerfelt furnace for aluminum alloys, Hauch Machine Tool Company, Springfield, Mass.; two 1,000 pound 200 kva each, Rennerfelt furnaces, for high speed steel (cast tools), U. S. High Speed Steel & Tool Corporation, Albany, N. Y.

Expansion of the business of the Eureka Fire Brick Works, Mt. Braddock, Pa., particularly in connection with products used by furnaces, it has been necessary to open an office in Pittsburgh, 1507 First National Bank Building, with E. L. Messler, president, in charge. Under the superintendency of H. Watson, the Mt. Braddock plant is running full.

Trade Publications

C-H Space Heaters are illustrated and described in a new 4-page two-color 8½x11 inch pamphlet No. 479, entitled, "Miscellaneous Applications of Electrical Heat." The pamphlet emphasizes numerous applications of electrical heat by means of flat standardized heaters, two feet long, 3/16 inch thick and 1½ inches wide. The entire heater is built to withstand hard service and vibration. All parts are enclosed and cannot jar loose. There is no porcelain, cement, asbestos or moulded insulation material used, the resistance being encased in sheet mica which in turn is encased in a steel jacket. After sealing, the heater is placed in an hydraulic press and 25 tons pressure applied. Ten of them, constituting a standard package, are packed in a box which affords a handy means of storing and identifying them. C-H Space Heaters have been used in scores of applications, notable among them being crane and hoist cabs, meter houses, valve houses, sprinkler riser houses, low temperature ovens including the new electrically heated bread ovens and many others. A partial list of the many applications is given in the new pamphlet. Methods of mounting, methods of connecting, dimension, wattages, weight, code numbers and prices are also included in the pamphlet. Space is provided for dealers' imprint as a large number of jobbers and supply houses now carry the space heaters in stock. They are a product of the industrial heating department of the Cutler-Hammer Manufacturing Company, Milwaukee and New York.

Fire Clay Test.

For the purpose of demonstrating the "air-set" feature of their high temperature cement, the Quigley Furnace Specialties Company, of New York, has laid up a 9-inch section of wall containing 70 standard fire brick as shown in the adjoining illustration. In laying up the wall the bricks were first dipped in water and then the ends and one side dipped in a batter of hytempite. Bricks were squeezed together and tamped to insure a close fit and a strong, thin joint secured.

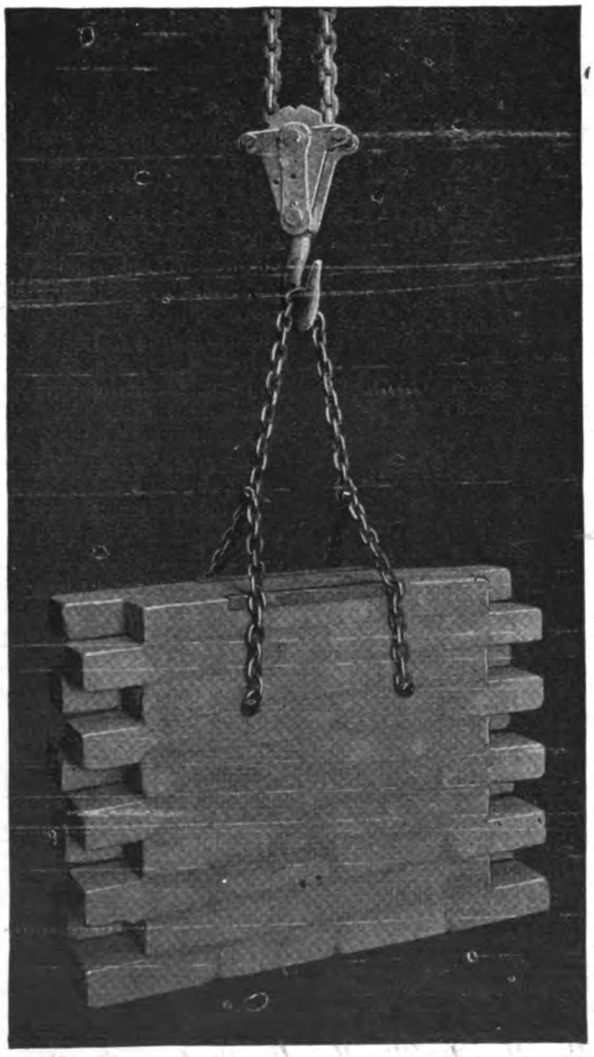
A reasonable time was allowed for the "sample wall" to set at atmospheric temperature, no heat being used to effect the bond. Holes were then drilled through the wall between the third and fourth courses from the top and bolts run through. To these bolts chain tackle for hoisting the wall section was attached.

The mechanical strength of the air-set joint has been conclusively demonstrated by shipping the wall section hundreds of miles by motor truck for exhibition purposes at conventions where it has been suspended for inspection and it still remains intact.

Walls and arches of furnaces or boiler settings are often subject to similar, though less severe, mechanical strain on account of vibration due to adjacent machinery, or other conditions which tend to open the joint; resulting in cracks, a broken arch or bulging wall and the ultimate collapse of the furnace structure. Thus the need of a shock-proof as well as heat-proof joint can be fully realized.

While this test illustrated the fact that a bond is secured at normal atmospheric temperature through the entire thickness of both courses, the action of heat will merely strengthen the bond which will retain its strength up to the fusing point of the brick itself.

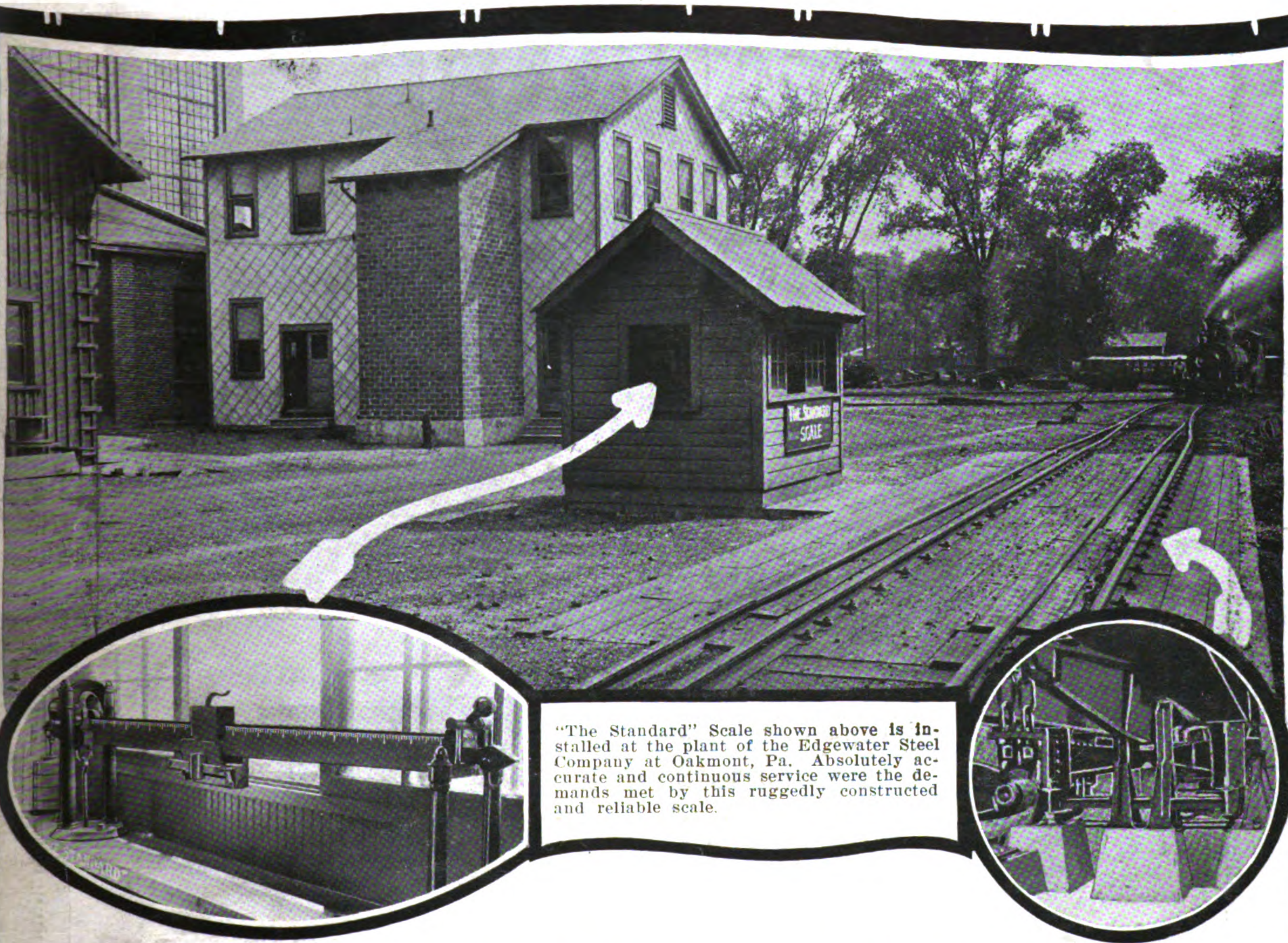
The weight of the section shown is approximately 525 pounds, of which 25 pounds represents the quantity of cement used.



Test on fire clay.

The Blast Furnace and Steel Plant

Pittsburgh, December, 1919.



"The Standard" Scale shown above is installed at the plant of the Edgewater Steel Company at Oakmont, Pa. Absolutely accurate and continuous service were the demands met by this ruggedly constructed and reliable scale.

"THE STANDARD" SCALES

Built with the problems of the steel plant in mind, "The Standard" Scales come up to the demands of the most exacting operating man or superintendent. Speed and accuracy are part of the scales themselves. Easy, quick reading of weights and ruggedly constructed to stand up under the unusually severe steel conditions encountered in the Steel Mill.

Scales of all types from the small counter scale graduated as fine as 1/16 ounce, up to the railroad track scales of heaviest capacity and longest platform. Write today for Catalog 84.

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